FACET

INDUSTRIAL APPLICATIONS

Making the world safer, healthier and more productive.

Facet
Filtration Group®

Definition

Liquid filtration is the removal of solids from liquids by flowing the contaminated liquid through a filter media that will retain the solids and allow only clean product to pass through.

Filtration Function

Using a surface filter medium to remove a volume of solids from a liquid requires that the medium should contain uniform pores smaller than the smallest particle to be removed. It should also be strong enough and possess sufficient area to hold the required volume of solids.
If a depth-type medium is used, the medium must contain an infinite number of small, irregular, continuous passages which give the solids a tortuous path to travel through. A depth medium of proper density will stop essentially all solids above a specified size.
The medium selected must withstand the manufacturer's required maximum allowable pressure drop and provide a margin of safety to cover both inadequate maintenance and line pressure surges commonly found in systems as a result of stops and starts. Facet uses both types of media in its product range.

General Applications

- Removing solids that may damage the aesthetic appearance of a product. Example: Solids in paint, bleach, liquid soaps, vinegar, plastic resin for use in plastic extrusion products.
- Removing solids which could affect chemical reaction of a product. Example: Catalyst fine in a refining process.
- Removing solids that could damage operating equipment. Example: Abrasive contaminant in hydraulic and lubricating oils.
- Removing solids that could affect a finished production item. Example: Contaminant in grinding and cutting oil of production equipment.
- Removing solids that could in some way affect the health of operating personnel. Example: Radioactive waste in primary coolant system on boiling water reactors and clean-up water in water reactor system.

Proper Selection Of Filters

Selection of media and vessel design determine the filter flow rate, dirt holding capacity, particle-size removal in one pass, overall cost of operation and initial investment.

Replaceable cartridge-type filters have wide usage and can be used in most any application. The two most important factors to consider when determining whether to use a replaceable cartridge type filters are the concentration of the solids to be retained by the filter and the required degree of filtration.

Cost Of Filtration

One realistic method of determining the "true cost" of filtration is the cost per pound of solids removed from a liquid. The four factors that make up this "true cost" are:

1. Cost of media (cartridges)
2. Cost of service parts (gaskets, etc.)
3. Cost of maintenance labor
4. Cost of downtime to service or maintain (value of lost production)

By totaling these four factors, determine a unit base as cost per pound, per gallon, per barrel, per year, etc. Although the cost of new equipment may vary, the "true cost" to the user is based on a cost per pound of solids removed. However, the achievement of a specific standard of quality cannot be measured by cost alone and this is the true value of a filter.

Capabilities

Today, more than ever, quality-conscious customers expect, and efficient plant operations dictate, the removal of solid contaminants from liquid products or processes. Filtration of particles too small for the eye to detect is essential to protect and improve quality, assure customer acceptance, prevent malfunctioning of equipment and reduce wear on machinery.

Facet filtration equipment has been designed for easy maintenance. The many easy service features reduce downtime and labor cost in maintaining equipment. These costs are important in evaluating both initial and future operational expenses.

With more than 75 years of constant research, product development and quality controlled production, Facet offers you maximum dependability, quality, innovative engineering and service.

M Series
Filter Housings

M Series filter housings use any of Facet's M Series high efficiency filter cartridges. A single pass of product through the system removes solids such as rust, dirt, scale, granules and other particles commonly found in liquid process streams.

M Series filter housings are available in vertical or horizontal configuration in several standard and custom sizes to accommodate specific flow and filtration requirements. They are designed with no internal moving parts to provide easy service and reduced maintenance costs. Each housing is manufactured using quality materials and workmanship to give long-lasting, dependable service.

M Series filter housings can be fitted with either multiple single-length cartridges, stacked 1, 2 or 3 high, or their double-length or triple-length equivalents.

Standard Design Features

- Body: Welded carbon steel construction — other materials available on request
- ASME Code, Section VIII, Div. 1 construction
- Designed for 150 psi @ 250˚F (10.3 bar @ 121 °C) — higher pressure and temperature ratings available on request
- Head closures:
  Style 1, thru-bolt; Styles 2 and 3, swing bolt
- Head gasket: Buna-N o-ring —other materials available on request
- Inlet and outlet permanently marked
- Exterior: Multipurpose prime coated
- Head lift furnished on 20” (508 mm) and larger

Standard Connections

- Inlet and outlet:
  Style 1, 3000# NPT; Styles 2 and 3, 150# RF (ANSI) flanged
- Side and bottom drain: 3000# NPT
- Vent and relief valve: ¾” 3000# NPT
- Pressure gauge: ¼” 3000# NPT

Options

- Air Eliminator
- Differential pressure gauge
- Pressure relief valve
- Manual drain valve
- Interior epoxy coating

SMALLER HOUSINGS AVAILABLE.
SEE All PURPOSE HOUSINGS SECTION

Development of new media and treatment of existing media permit use of these coalescers for essentially all process streams where entrainment of solids and liquid contaminants are present.

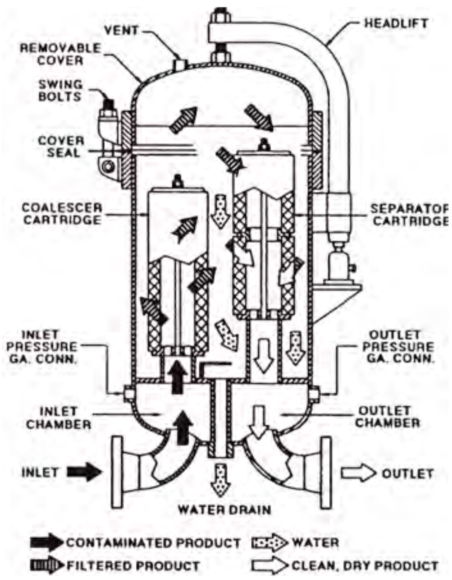


Figure 1. A typical two-stage vertical coalescer

Three basic designs of cartridge-type coalescers are available for application in chemical processing. They are comprised of single-stage, two-stage, and three-stage units wherein one, two or three types of cartridges are provided. The configuration of each design will vary with the process application and efficiency requirements.

In determining the design of coalescer to be used, the maximum operating conditions and minimum performance efficiencies must be established. With the performance requirements established, the determination of the basic design and media to be utilized is made. Among the various factors which must be considered in arriving at the correct design are the physical characteristics of the fluid to be processed. This applies not only to the continuous phase but equally well to the discontinuous phase. Since all coalescers, whether one-, two-, or three-stage rely to a greater or lesser degree on the natural forces of gravity, the difference in the specific gravity of the two liquids is important. As will be discussed later, the discontinuous phase may be lighter or heavier than the continuous phase without affecting the efficiency of the unit, provided sufficient differential in gravity exists. Since the natural forces of gravity enter into the operation of the equipment, the viscosity of the fluids being processed must also be taken into consideration.

One of the most important single factors to consider in the design of cartridge type coalescers is the interfacial tension between the continuous and discontinuous phase. Since the interfacial tension controls the maximum droplet size of the discontinuous phase and relative wetting of separating surface, the selection of a coalescing media is of prime importance when low interfacial tension values are to be encountered.

Since most fluid process streams contain solids contamination of one form or another, consideration must be given to the type of contaminant involved and the amount of contaminant in the fluid. The next factor that affects the ultimate design is the particle size distribution. From the particle size distribution curve, a determination of how much of the solids contaminant to be retained in the cartridges can be made. The fact that the solids to be filtered are either hydrophobic or hydrophilic is of importance. If a solid is hydrophobic it will be borne through the system by the hydrocarbon phase and will be more difficult to filter. The hydrophilic solid is carried by the discontinuous water phase and during the mechanical action of coalescence, this solid will largely be deposited on the media of coalescer cartridge.

Coalescer Cartridge

The coalescer cartridge is made up of one or more layers of media. This media is primarily a porous membrane which retains its dimensional stability by the use of thermal setting resins or binders. Careful selection of the media is imperative to insure that the fluid stream being processed does not remove the binder in the media, which would result in media collapse and contamination of the fluid. In order to assure that coalescing of the discontinuous phase is complete, the media must possess an infinite number of irregular continuous passages of very small diameter. These passages are such that by impingement and preferential wetting of the media surface, the discontinuous phase is commingled to a sufficient size where it can be removed from the continuous phase by gravitational force or by contacting a second stage, commonly referred to as a separator cartridge.

Because of the extremely small pore size of the irregular continuous passages of the coalescing media an accessory function of the media becomes one of removing solids particles. Therefore, if a given coalescing media possesses a sufficiently fine pore size to affect coalescing of a finely dispersed discontinuous phase, it will, at the same time, provide excellent filtration characteristics. The degree of filtration will be in direct relation to the size of the openings and the total solids retention will vary with the type and depth of media used.

One of the most important single factors regarding the application of cartridge-type coalescers to fluid process streams is the interfacial tension between the continuous and discontinuous phase. Below values of 20 dyne/cm, the size of the particles in the dispersed phase becomes progressively smaller and coalescing becomes more difficult. Media is available which will coalesce at values of less than 10 dyne/cm; however, additional consideration must be made for these reduced values. Under these conditions, the media of the coalescer cartridge must have even smaller diameter pores to insure that all of the dispersed phase contacts one or more surfaces during its passage through the media. Preferential wetting of the media by the dispersed phase will facilitate complete coalescing.

Coalescing media is provided in many forms, the most common being multiple layers of media formed into cylindrical cartridges ranging in size from 4 to 6 inches in diameter and 10 to 57 inches in length. The direction of flow can be either outside-to-inside or inside-to-outside. The most common flow pattern in cartridge type coalescers is inside-to-outside. Higher flow rates can be obtained in the inside-to-outside cartridge coalescer due to the fact that the linear velocity of the fluid passing through the media is progressively reduced as the fluid approaches the outer extremities of the cartridge. This condition permits the discontinuous phase to be commingled into a larger droplet size with the result that the load on the second stage is greatly reduced.

Other forms of coalescing media in bulk form are available and are widely used in some applications. Among the more common types of bulk coalescing media are bonded and unbonded glass fibers, metallic wool of various types, and treated wood fibers. Bulk type coalescing media of the types mentioned herein are normally used in single-stage coalescers. The density of the bulk coalescing media will vary with the type of media used in the installation. Typical bulk densities of this type media will range from 1½ to 4 pounds/cubic foot for glass fibers and up to 20 pounds/cubic foot for metal wool.

The degree of coalescing and the nominal pore size of the bulk cartridge can be relatively controlled by the density of the material. Unbonded glass fibers lend themselves to applications wherein the solvent action of the continuous or discontinuous phase prohibits use of bonded materials. Metallic fiber can be used to a great advantage in applications where the pH of the fluid being processed exceeds the limits of glass fibers or other forms of conventional coalescing media. Other forms of coalescing media are also available such as polyethylene encapsulated fibers, inorganic fibers and sintered materials.

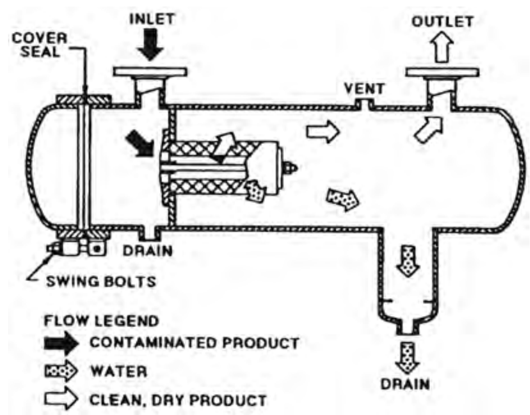


Figure 2. A typical single-stage coalescer

Separator Cartridge

The separator cartridge is made up of a single media. This media must allow free passage of the continuous phase and can be treated to repel the discontinuous phase. The separator cartridge is normally comprised of one type or layer of media. The type of media will vary with the application. The separator media must permit maximum flow of the continuous phase at minimum pressure differential. This media must be superficially treated or possess inherent characteristics which will permit free passage of the continuous phase while repelling the discontinuous phase. A common media for this application is silicone-treated cellulose fibers.

The media must be dimensionally stable in the presence of the fluids being processed since any swelling of the fibers due to absorption will result in a change in the pore size of the media. Effectiveness of the separator cartridge is entirely dependent upon the repellent characteristics of the media to the discontinuous phase and the critical pressure at which the discontinuous phase will be forced through the pores of the media. It is, therefore, of absolute necessity that the pore size of the media remain unchanged; otherwise, the critical pressure differential will be exceeded and the cartridge will fail to repel the discontinuous phase. Critical rupture pressure can be expressed by the following formula:

$$p = 2\gamma/r$$

where p is the differential pressure (in. Hg), γ is the interfacial tension (dyne/cm), and r is the radius of maximum pore (micron).

Other materials are available for use as a separator media. One of the more common materials is the use of polytetrafluoroethylene coating on fine-mesh wire filter cloth. This particular type of separator cartridge lends itself to those applications where the continuous phase would wash out or otherwise be detrimental to the silicone-impregnated cellulose materials. An auxiliary function of the separator cartridge is one of filtration. Since the pore size of the separator media is controlled, this media then becomes a secondary filter to prevent migration of fibers from the preceding stages; or in the event of mechanical failure of the coalescer cartridge, the separator cartridge will prevent solids contaminant from flowing into the effluent stream.

Filter Cartridge

In three-stage units the first stage is made up of single or multiple installations of one of the various types of filter cartridges. The function of this cartridge is one of removing solids contaminants only. Its purpose is to reduce the loading on the second-stage coalescer cartridge, thereby greatly improving coalescer life and to insure ultimate efficiency from the media. The direction of flow through the filter cartridge is from outside-to-inside. This design permits maximum solids retention in a minimum envelope size.

The selection of media for the filter cartridge will be determined by a number of factors; the most important of which are chemical characteristics of fluid to be processed, temperature, amount of solids contaminants in the process stream, particle size distribution, maximum particle size permitted in effluent, and minimum solids retention before change is required. The cartridge may be made from any of the various common media such as pleated cellulose, woven materials, and impregnated organic fibers. For those applications where the process stream prevents use of bonded or impregnated media due to solvent action, other materials are used. There are now available polyethylene-encapsulated fibers which retain all filtration characteristics of impregnated cellulose with regard to pore size and offer essentially zero media migration. This material now affords economical filtration to numerous process applications which are beyond the operational limits of low cost media.

Two-Stage Unit

A typical two-stage vertical coalescer is shown in Figure 1. This design is commonly referred to as a filter separator.

The contaminated fluid enters the lower inlet chamber and flows upward into the inside of the multiple coalescer cartridges. In this area of reduced velocity, the initial phase of commingling is begun. When the fluid contacts the initial surface of the media, any large particles of contaminant will be filtered from the stream. As the fluid continues its tortuous passage through the media, the discontinuous phase is impinged upon the infinite surfaces and commingling of the dispersed particles results. As the two liquid phases near the outer surface of the coalescer cartridge, the discontinuous phase has been coalesced to large droplets. Simultaneously with coalescing of the discontinuous phase the media is filtering solids contaminant from the process stream.

As the two liquid phases flow from the outside surface of the coalescer cartridge, the large droplets of the discontinuous phase will fall by gravitational force to the sump or collection area. The lower velocity in this area greatly reduces the possibility of rupture of the coalesced droplets of the dispersed phase. Any remaining entrainment of the discontinuous phase will be repelled by the separator cartridge. In addition to preventing any passage of the discontinuous phase into the effluent stream this cartridge also performs as a secondary filter in event of mechanical failure or bypass of the coalescer cartridge.

The two-stage unit is also provided in horizontal configurations. In this design the sump for accumulation of the discontinuous phase may be located below or on top of the horizontal vessel. Normally the coalescer cartridges are installed in one end of the vessel and the separator cartridges in the opposite end. The void area between the ends of the cartridges provide fall-out area for the discontinuous phase. This type of two-stage design is particularly desirable where the viscosity of the fluids being processed is relatively high or where the differential gravity between the two products is relatively low. This design further lends itself to application on streams where the discontinuous phase is lighter than the continuous phase with the result that the accumulation sump must be installed on the top of the vessel.

Another design of the two-stage unit follows the general configuration of the vertical design wherein the unit is rotated 90 degrees on its normal axis and installed in a horizontal position. The coalescer cartridges are installed in the lower section of the horizontal shell and the separator cartridges are installed in the upper or top section of the horizontal vessel. A vertical accumulator sump for collection of the discontinuous phase is added to the horizontal chamber.

Two-Stage Unit Application

Typical of a two-stage coalescer installation is the following:

Process problem: Removal of undissolved water containing hydrochloric acid from perchloroethylene.

Operating conditions:

Required performance: Nominal size of effluent solid

	Heavy Phase	Light Phase
Feed Rate lb./hr.	112,000	10,000
Specific gravity	1.6	1.0
Liquid	Perchloroethylene	Water
pH		5.0
Temperature, °F		122
Pressure, lb./ sq. in. gauge		150

particle five microns. Effluent stream to contain not more than 5 ppm undissolved water.

For this installation a horizontal two-stage unit using multiple coalescer and separator cartridges was used. This design was selected primarily because the discontinuous water phase is lighter than the continuous phase. A second important factor in selection of this design was the high concentration of water in the process stream. The settling area between the two stages permits the major portion of the water to rise to the accumulator sump before reaching the separator cartridges.

The physical and chemical characteristics of the continuous phase permitted use of conventional coalescing and separating media. The hydrochloric acid dissolved in the water phase had reduced the pH to five which is within normal operating limits of glass fibers used in the coalescer cartridges and silicone treated cellulose in the separator cartridges. The operating temperature was considerably less than the 275°F permitted for this type of media.

All metal in contact with the process fluid was of stainless steel and all non-metallic parts are resistant to the corrosive action of the hydrochloric acid solution.

Single-Stage Unit

A typical single-stage coalescer is shown in Figure 2. Single-stage units may be comprised of multiple installation of coalescer cartridges as illustrated, or the entire cross section of the vessel may be packed with a bulk-type media. This design is used when the differential in specific gravity of the two liquid phases is sufficient to provide separation by gravitational force or where a separator cartridge would not possess sufficient repellent characteristics to the discontinuous phase.

In the design of single-stage units, the size of the vessel is of prime consideration since separation is entirely dependent upon the difference in the density of the two liquids. Linear velocity in the settling area of the vessel will vary from 0.25 ft/sec on light fluids to 0.10 ft/sec on heavier products. If the discontinuous phase is lighter than the continuous phase the accumulator chamber is placed on top of the vessel.

The contaminated fluid flows into the large inlet chamber and the immediate reduction in velocity will permit a portion of the entrained discontinuous phase and solids to settle out. The discontinuous phase will then pass through the lower half of the coalescer pack. Any remaining entrainment is coalesced and solids are filtered from the fluid as it flows through the media.

Single-Stage Unit Application

Typical of a single-stage coalescer installation is the following:
Process problem: Removal of entrained water containing sodium hydroxide from butadiene.

Operating conditions: Specific gravity 0.628 at 60°F. Flow 200 gpm Entrained water 10% volume; pH of water 9.5 to 10.0. Solids contaminant negligible.

Required performance: Water not to exceed 50 ppm in effluent. For the above installation a single-stage horizontal unit using a bulk-type coalescer cartridge was used. The design was selected because the pH value of the water phase exceeds the recommended values for secondary separator cartridges of conventional media. The media selected was a fine grade stainless steel wool compressed to an optimum density to provide maximum contact surface for coalescing and minimum differential pressure.

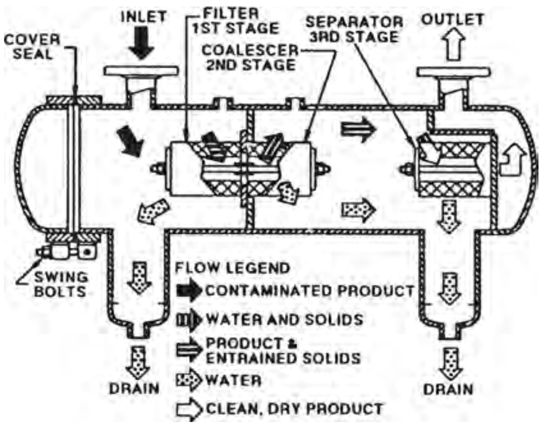


Figure 3. A typical three-stage horizontal coalescer

Three-Stage Unit

A typical three-stage horizontal coalescer is shown in Figure 3. This unit consists of coalescer and separator cartridges as used in the horizontal two-stage device, and is provided with a first-stage cartridge whose primary function is the removal of solids contaminant from the stream. The product enters the low-velocity inlet chamber where the larger particles of solids contaminant will settle out by gravitational force. In this area, any sludge or other heavy entrainment will also settle out and accumulate in an auxiliary sump. Controls may be provided on the auxiliary sump for automatic blowdown of the accumulated material. As the fluid flows through the first-stage filter cartridge, the solids contaminant is filtered from the stream. Simultaneously, some initial coalescing of the discontinuous phase may occur depending upon the media used in the filter cartridge and the characteristics of the discontinuous phase.

As the filtered product and discontinuous phase flows from the first-stage filter cartridge, it is discharged directly into the inside of the second-stage coalescer cartridge. The second-stage coalescer cartridge then performs the function of completing the coalescing of the discontinuous phase and filtering out any remaining solids which may be in the stream. Immediately downstream from the coalescer cartridge is a void area which provides settling space for gravitational fallout of the discontinuous phase. As the product flows to the outlet through the third-stage separator cartridge any remaining entrainment of the coalesced discontinuous phase is repelled and the clean, dry product leaves the vessel.

Use of a three-stage device permits a very wide selection of filter and coalescing media. This unit offers great advantages for those installations where the solids contaminant in the process stream is relatively high, i.e., 5 mg/l. The first stage filter cartridges can be removed from the unit without disconnecting any of the piping or without removing the cartridges in the second- or third-stages.

Application

The use of cartridge-type coalescers, as applied to the chemical process industry, has resulted from the development of new media and treatment of existing media to permit their use. The art of coalescing has advanced to a point where there are only a few isolated process systems where cartridge-type coalescers cannot be utilized.

Cartridge-type coalescers can be provided for essentially all process streams where entrainment of solids and liquid contaminant is present, the only limiting factors being equal density of the two liquid phases or essentially zero interfacial tension.

Two-Stage Vertical Coalescer Separator Housings

VCS Series

Facet VCS Series two-stage vertical coalescer separator housings are mechanical devices designed to filter solids and separate two immiscible liquids. Using Facet's first-stage coalescer cartridges and second stage separator cartridges, they provide the highest degree of water and solids removal available.

These quality Facet products are designed for installations in petrochemical plants, refineries, power plants, bulk storage terminals, offshore platforms, manufacturing plants and many other industrial applications.

Standard Housing Designs

- Body: Welded carbon steel construction — other materials available by request
- ASME Code, Section VIII, Div. 1, stamped and certified
- Designed for 150 psi @ 250 °F (10.34 bar @ 121 °C) — higher pressures and temperatures available by request
- Inlet and outlet permanently marked
- Exterior: Prime coated
- Swing bolt head closures
- Head Gasket: Buna-N o-ring —other materials available by request
- Head lift furnished on 18" (457 mm) OD and larger

Standard Connections

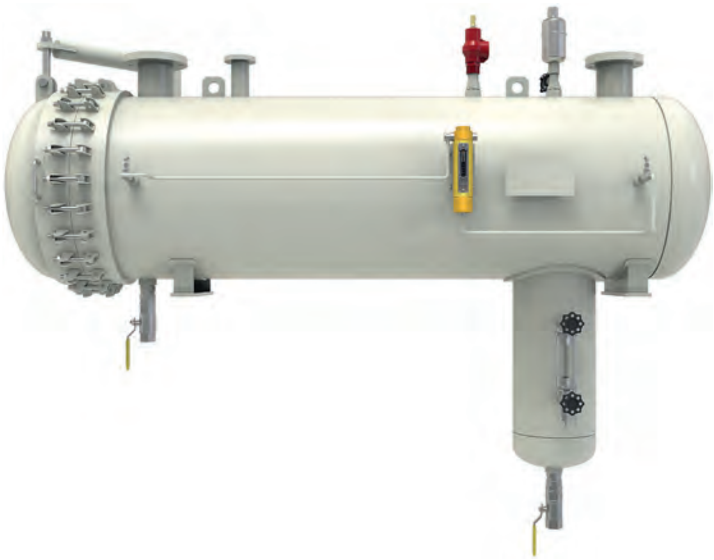
- Inlet and outlet: 150# RF (ANSI) flanged
- All other connections are 3000# NPT couplings

Options

- Automatic air eliminator
- Differential pressure gauge
- Immersion heaters
- Liquid level gauge
- Pressure relief valve
- Sampling probe
- Special connections available
- Drain valves
- Blind cover for pilot control mounting flange
- Interior epoxy coating

Single-Stage Coalescer Housings

HP Series



Facet HP Series single-stage coalescers use wafer repacks to remove gross amounts of water and solids from hydrocarbons. They are available in several standard sizes to accommodate flows from 10 to 2000 gpm (38 to 7570 lpm). They provide protection to filtration systems from gross amounts of water and solids that are commonly carried through inbound transport pipelines.

HP Series housings offer an option of using coalescer cartridges for more efficient solids separation and liquid-liquid water separation. Use of an adaptor kit permits returning to the use of repacks at any time.

HP Series housings have no internal moving parts and are designed for easy servicing, thereby reducing maintenance costs. Each housing is manufactured with quality workmanship and materials to give long- lasting and dependable service.

Variations from standard design are available in higher pressures, other materials, special connections or other quick opening closures.

Standard Design Features

- Body: Carbon steel construction
- ASME Code, Section VIII, Div. 1, stamped and certified
- Designed for 150 psi @ 250 °F (10.34 bar @ 121 °C)
- Housing Closure:
  Blind cover on housings less than 14” (356 mm) OD
  Swing bolt closure on housings 14” (356 mm) OD and larger
- Housing Covers:
  Removable on housing up to 14” (356 mm) OD
  Hinged on housings 14” (356 mm)
  thru 36” (914 mm) OD
  Rotating davits on housings 42” (1067 mm) OD and larger
- Head Gasket: Buna-N — other material available by request
- Exterior: Prime coated
- Saddle supports for pier mounting

Options

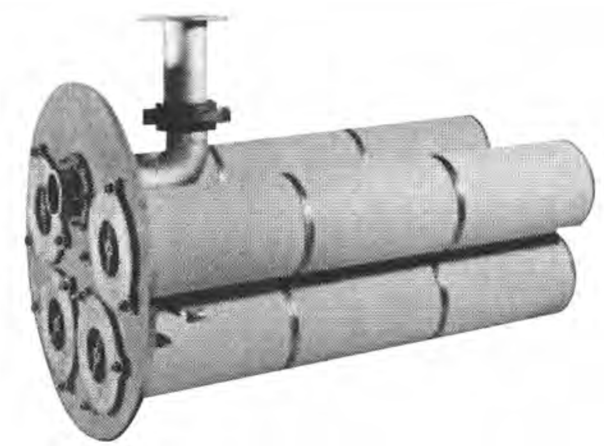
- Steel stands available
- Internal epoxy coating

Standard Connections

- Inlet and outlet: 150# RF (ANSI) flanged
- All other connections are 3000# NPT female type couplings

Conversion Kits

CKS Series



Standard Design Features

- Kits contain all necessary parts for conversion including hardware, cartridges and gaskets.

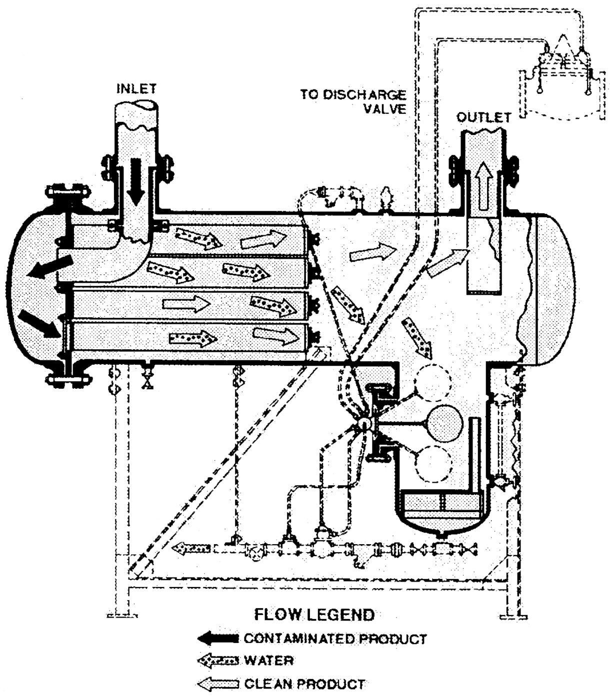
Materials

- Cartridge holding plates are aluminum and other parts are stainless steel. Kits contain all necessary parts for conversion including hardware, cartridges and gaskets.

Facet CKS Series conversion kits are designed to upgrade HP Series separators which presently use excelsior repacks in order to provide more efficient solids filtration and water separation.

They are designed for retrofit in vessels without need for alteration to basic vessel design in order to permit use of current design first stage coalescer cartridges which flow inside-out. Use of various Facet cartridges will permit various efficiencies desired by the user. Conversions enable use of out-of-service equipment which would otherwise be in storage or disposed of by sale or scrap. Kits installed without vessel modifications permit return to use of excelsior cartridges when desired.

CKS Series conversion kits permit the use of any of the Facet CA, CR, CB, CC, CMP, AG or U5 Series cartridges, all 6” (152 mm) OD, rigid, high flow cartridges. All cartridges are capable of withstanding differential pressure of 75 psi (5.17 bar) without structural failure.



SELECTION OF KITS

MODEL NUMBER	NUMBER OF CARTRIDGES	DESIGNED TO CONVERT
M-398	1	HP-80
M-479	4	HP-200
M-397	5	HP-300
M-620	9	HP-500
M-396	10	HP-600
M-478	13	HP-750
M-503	17	HP-1000

NOTE: For information on additional kits available, consult your Facet representative.

Carbon and Clay Treater Housings

F Series

Standard Housing Design

- Welded carbon steel construction
- ASME Code, Section VIII construction, stamped and certified
- Design pressure: 150 psi @ 250 °F (10.3 bar @ 121 °C)
- Inlet and outlet permanently marked
- Interior: Epoxy coated
- Exterior: Prime coated
- Removable cartridge mounting post
- Swing bolt closure
- Buna-N closure gasket
- Hydraulic headlift

NPT Connections

- ¼" differential pressure gauge
- ¾" pressure relief valve and vent
- 2" main drain
- 1½" side drain

Options

- Automatic air eliminator
- Differential pressure gauge
- Pressure relief valve
- Sampling probe
- Cartridge hoist assembly
- Removable bundle design

DATA

MODEL NUMBER	LIQUID VOLUME		REQUIRED CARTRIDGES	DRY WEIGHT	
	gal	ltr		lbs	kgs
13F3-C	288	1090	39	1913	868
24F3-C	456	2067	72	3250	1474
31F3-C	702	2657	93	4459	2023
40F3-C	874	3308	120	5380	2440
50F3-C	1167	4417	150	6976	3164
60F3-C	1442	5458	180	8298	3764
67F3-C	1570	5942	201	9602	4355

Weights and volumes are approximate.

Definition

Air/gas filtration may be defined as the art of removing solid particulate matter from dry air/gas streams to free the stream of dust and other abrasive solid particulate matter. Air/gas filtration and separation may be defined as the art of removing solid particulate matter and liquids in suspension in air/gas streams. The field of air/gas filtration and separation filtration is one of a combination of removing either solids, or solids and liquids such as water and hydrocarbons, which may appear as slugs or in the form of mist or fog.

The above may be considered entrainment separation and while water or hydrocarbons may appear in an air or gas stream in a vapor form, the term entrainment separation would not apply to the removal of such contaminants in a vapor form. This removal would be properly classified under the category of dehydration which is sometimes referred to as purification. Entrainment removal will not lower the dew point of a gas stream; this can be accomplished only by vapor removal.

How Air/Gas Equipment Functions

The filtration of air/gas products is accomplished by passing the air or gas through a suitable filter media which permits the passage of the air or gas but retains the solids. This is a pure function of filtration identical to that of filtration of liquids, and is generally used only in cases of dry air or gas streams. However, solids may be removed in the presence of liquid entrainment, but the specific term “filtration” should not imply the liquids will be removed.

The filtration of air or gas may be further expanded by the use of an impingement baffle in the housing which would cause the knockout of coarse solids and entrained water or hydrocarbon. After the baffle, the air or gas then flows through a filter media which removes the finer solids; however, any remaining water or hydrocarbon after the baffle would pass through such a media.

Air/ gas entrainment filtration separation is accomplished by passing the product through a suitable first-stage baffle, then through the second stage coalescer cartridge which coalesces the water and hydrocarbons and removes the solids prior to entering the third stage. The third stage is a cartridge very similar to that of a filter cartridge except that special treatment makes it a water and hydrocarbon repellent member and causes the cartridge to repel discrete droplets of both water and hydrocarbons. It is important that a large quiescent area be provided in the sump for the entrainment separator to function properly.

This permits the impinged droplets to fall out before they might be carried into the stream.

In cases of large gross amounts of solids, it is advisable to install a prefilter section in the housing to remove the gross solids, thus permitting the second-stage coalescer cartridge to remove only the finer solids and coalesce the water and hydrocarbons.

General Applications

- Removing solids and water which may damage gas-measuring equipment.
- Protecting dry bed desiccant towers from free water, oil distillate, etc.
- Removal of liquids and solids from fuel gas lines. Cleaning and conditioning charge stock in synthesis plants. (Example: Anhydrous ammonia synthesis using natural gas as a charge stock).
- Removal of free liquids and solids at inlet to compressor stations and between compressor stations. On compressor discharge to remove lubricating oil.

Selection of Equipment

The selection and size of equipment required to remove solids, water or hydrocarbon mist or fog from air or gas streams will depend on the flow rate, operating conditions, and physical characteristics of the gas. It is necessary to remember that any effective equipment must be designed to remove the desired amount of solids and other contaminants in one pass at full flow.

The amounts and types of solid and liquid contamination to be removed will have a bearing on the type of equipment and type of media selected. The location of the equipment also becomes a factor since proper operation of equipment frequently demands regular attention.

A basic fundamental in the selection of this type of equipment is the manufacturer’s history of ability to upgrade media that will be interchangeable with the original media. In other words, is it possible to use cartridges with recently developed media that are dimensionally interchangeable with the cartridges originally purchased with the equipment? If so, no housing modifications are necessary to take advantage of advances in the state of the art. Facet standard cartridge dimensions permit such upgrading.

Air/Gas Filtration and Separation
General Description

Cost of Operation

Cost of operation of air/gas filtration and separation equipment is based primarily on operating costs.

Original equipment costs should be secondary. Filtration and separation equipment has a long life so reasonable differences in acquisition costs, apportioned over a long life, become minor factors in cost.

The true cost of operation is based on the cost per pound of solids or cost per gallon of liquids removed from the air or gas. Thus five factors make up the cost of operation:

1. Cost of media (cartridges, etc.)
2. Cost of service parts (gaskets, etc.)
3. Cost of maintenance labor
4. Cost of downtime to service or maintain (value of lost production)
5. Horsepower requirements versus ΔP

By accumulating the total of these five factors, a cost per unit may be arrived at on several bases, such as pounds of solids or gallons of liquid removed per million cubic feet of gas (month, year, etc.)

Design Criteria

Complete data is the prerequisite of any good design criteria. Therefore, all flow conditions, amounts of contamination, solids or liquids, operating pressure, operating temperature, and desired efficiencies all become an integral part of the data necessary for the adequate sizing and design of the proper equipment.

In designing a filter or an entrainment filter separator for air or gas, consideration must be given to the types of solids to be retained. As an example, consider the density of the solid with regard to the number of cartridges needed to hold a given volume of solids. It requires fewer cartridges to retain a given weight of a dense solid than is required to retain the same weight of a solid of lesser density. Also, particle size distribution affects the design by aiding in determining the volume of solids the specific cartridge can be expected to retain.

Capabilities

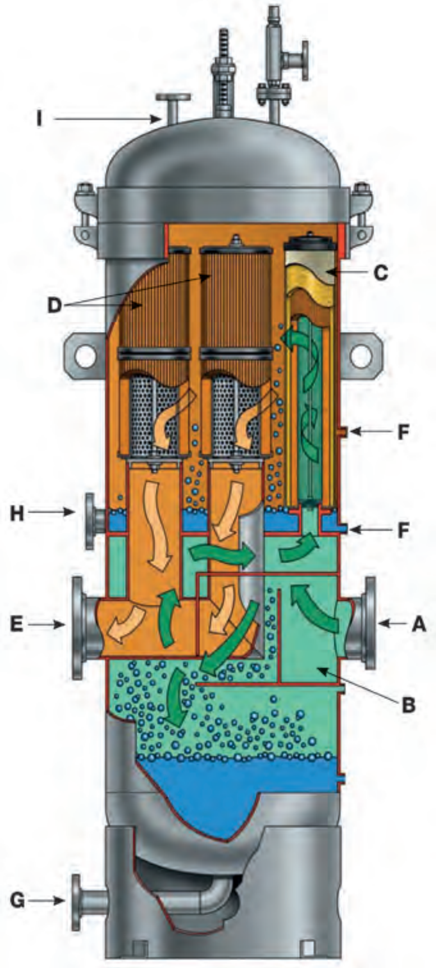
More than 75 years of experience in the process industry and in the removal of solids and water from aviation fuels has led to Facet's development of the media and housing designs needed to cope with the increasing demands for filtration and liquid removal from air and gas streams.

Facet's pipeline and out-of-storage experience can be used to a great advantage in gas transmission and out-of-cavern operations in the gas industry.

This, coupled with our experience in all types of filter applications, also provides the basis for handling in-plant applications of processing plant air for use on compressors and all types of air operations.

Air/Gas Vertical Housings

3AGB Series



ITEM	DESCRIPTION
A	Inlet
B	Impingement Baffling
C	Coalescer Cartridge
D	Separator Cartridge
E	Outlet
F	Liquid Level Control Connection
G	Lower Drain Connection
H	Upper Drain Connection
I	Vent

The Facet 3 AGB Series vertical housing permits easy access for inspection or change out of media. The baffle plates at the inlet remove a large amount of solid particulate matter and entrained liquids which are collected in the quiescent sump. The large sump area also provides for slug control.

Use of the impingement baffle permits coalescer cartridges to function more efficiently in the removal of microscopic solids and the fine liquid entrainment.

Operation

Gas stream enter housing at point (A). Through the use of baffling at point (B), impingement of solid particulate matter occurs. A certain amount of liquid entrainment will drop out with solids and collect in quiescent sump. Mist and minute solids will flow upwards and enter coalescer cartridges, points (C). Oil mist particles will be coalesced and solid particulate matter will be removed. Gas stream will flow from inside-out. Coalesced droplets will be repelled by specially treated separator cartridges, point (D). Liquid will fall to bottom. An upper drain connection is available for this liquid to be removed at point (H). Gas stream will flow through separator cartridges (D) outside-in, and on through internal piping to outlet point (E).

Standard Housing Design

- Body: Welded carbon steel construction
- ASME Code, Section VIII, Div. 1, stamped and certified
- Designed for 150 psi @ 250 °F (10.3 bar @ 121 °C)
- Exterior: Prime coated
- Swing bolt head closures
- Head-Gasket: Buna-N o-ring —other materials available by request
- Headlift furnished on 20" (508 mm) OD and larger

Standard Connections

- Inlet and outlet: 150#RF (ANSI) flanged
- All other connections are 3000# NPT couplings

Options

- Differential pressure gauge
- Automatic drain valves
- Liquid level gauge

21 Series & 22 Series Housings

The Facet VF-21SB/22SB series housings, are economical, compact housings for superior in-line filtration protection when used with standard 21 Series or 22 Series cartridges.

Depending on the 21 Series or 22 Series cartridge installed, these housings may be used as filters, absorptive filters, filter separators or air/gas entrainment separators to remove solids, water mist or hydrocarbon carryover.

Both interior and exterior surfaces of the carbon steel body are epoxy coated to protect against corrosion. This sturdy, single cartridge housing is easy to maintain and requires only 2" (51 mm) base clearance for cartridge change out.

Standard Housing Design

- Carbon steel body
- Aluminum head
- Epoxy coated internally and externally
- 150 psi (10.3 bar) design pressure
- Swing bolt quick open closure
- Buna-N o-ring closure gasket
- Vent and drain connections w/ brass petcocks provided
- 1½" NPT inlet and outlet connections

VESSEL OPTIONS

MODEL	DESCRIPTION
VF-21SB	Housing only
VF-21SB-PG	Housing w/ Direct Reading Differential Pressure Gauge
VF-21SB-PGS	Housing w/ Direct Reading Differential Pressure Gauge & Sight Glass
VF-21SB-PGWP	Housing w/ Direct Reading Differential Pressure Gauge & ¾" NPT Coupling for Water Probe
VF-21SB-S	Housing w/ Sight Glass
VF-21SB-WP	Housing w/ ¾" NPT Coupling for Water Probe
VF-22SB	Housing only
VF-22SB-PG	Housing w/ Direct Reading Differential Pressure Gauge
VF-22SB-PGS	Housing w/ Direct Reading Differential Pressure Gauge & Sight Glass
VF-22SB-PGWP	Housing w/ Direct Reading Differential Pressure Gauge & ¾" NPT Coupling for Water Probe
VF-22SB-S	Housing w/ Sight Glass
VF-22SB-WP	Housing w/ ¾" NPT Coupling for Water Probe
644160	Mounting Bracket
644964	Grounding Cable

Differential Pressure Gauge- The piston-type differential pressure gauge provides a simple visual warning. When 15 psi (1.03 bar) differential pressure is reached, the gauge indicator moves from green to red zone. This warning will prevent premature cartridge change-out.

Water Sight Glass- The water sight glass provides an easy means to detect water in the sump. The weighted ball, visible in the sight glass, will float only when water is present. The floating ball is an indication water should be drained from the housing to prevent both cartridge contamination and water traveling downstream from the housing.

ACCORDING TO THE REQUIREMENTS OF EUROPEAN PRESSURE EQUIPMENT DIRECTIVE (PED) 2014/68/EU ART. 4.3, WITHIN THE OPERATING LIMITS PROVIDED ON VESSEL NAMEPLATE AND SUMMARIZED BELOW, THESE FILTERS ARE DESIGNED AND MANUFACTURED IN ACCORDANCE WITH THE SOUND ENGINEERING PRACTICE AND EXEMPT FROM CE MARKING AND CERTIFICATION: 10 BAR(G) @ 35°C FOR AV-GAS AND JET FUEL.

Facet SuperFlex housings are small, economical, carbon steel housings that may be used as filters, filter separators or air/gas separators depending on the cartridges used. Stainless steel construction is available. Contact your Facet Representative for details.

Liquid Filtration

MS Series SuperFlex Filters remove solids from liquids, compressed air or natural gas. Facet's M Series (high efficiency, screen wrapped or multipleated) cartridges, stacked 1, 2 or 3 high, are used.

Liquid-Liquid Separation

VCS Series SuperFlex Filter Separators remove water and solids from gasoline, diesel fuel, fuel oil, insulating oil, kerosene, lube oils, solvents and many other petroleum based products where water content is a problem. This housing requires Facet Model CC-23-7 or CC-23C coalescer cartridges and Model CS-94 or CS-94C pleated paper separator cartridges, stacked 1, 2 or 3 high.

Air/Gas Separation

AGS Series SuperFlex Air/Gas Separators remove oil, water, mist and solids from compressed air or natural gas. This housing requires Facet Model CC-23-7 coalescer cartridge and Model CS- 98-2 pleated paper separator cartridge.

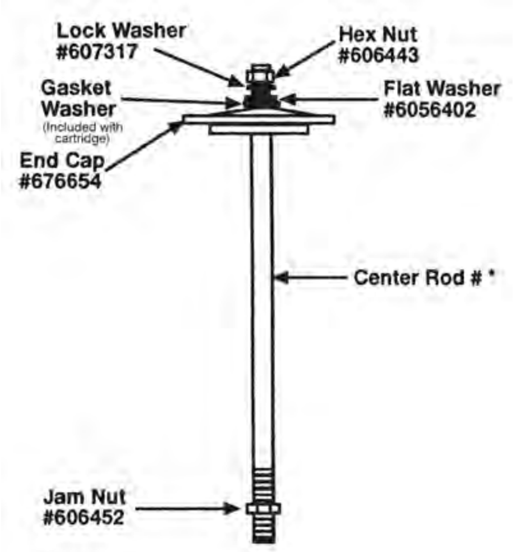
Standard Housing Design Features

- Welded carbon steel construction
- ASME Code, Section VIII, Div. 1, stamped and certified
- Designed for 250 psi @ 250 °F (17.23 bar @ 121 °C)
- Main closure: Blind flange
- Head gasket: Buna-N o-ring —other materials available on request
- Vent connections: ¾" NPT
- Drain connections: ¾" 3000# NPT
- Inlet and outlet connections: 2" 3000# NPT
- Interior: Epoxy coated
- Exterior: Shop primer

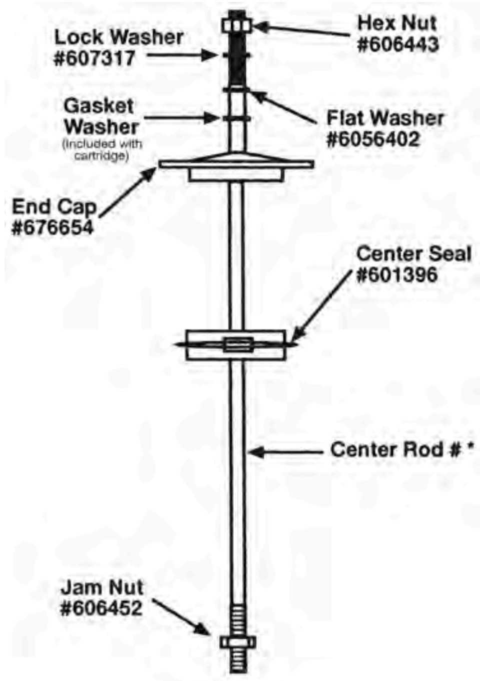
Options

- 304 stainless steel construction
- Air eliminator
- Drain valve
- Pressure gauge assembly
- Pressure relief valve
- Adjustable support stand

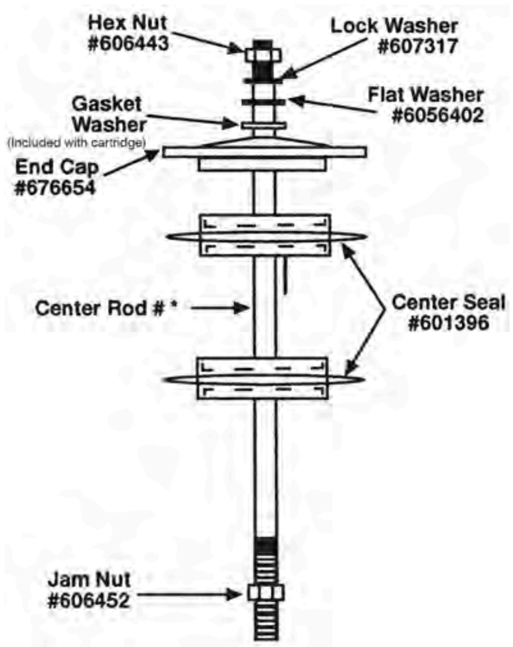
For 6" OD (152 mm) 3½" ID (89 MM) 14½" (368 mm) LG CARTRIDGES



1 DEEP



2 DEEP



3 DEEP

CENTER ROD	
Overall Cartridge Length (in)	Part Number
14½	678901
28¾	678905
43¼	678907
57¼	678909

Note: Nuts, washers and center rods are stainless steel.

Yoke Bypass Valve

The Facet yoke bypass valve was developed to allow continuous flow in applications where it is critical not to stop the process.

Rather than expensive instrumentation and valves used to automatically bypass the vessel, this yoke bypass valve will open at a set pressure allowing product to bypass the elements.

The yoke bypass valve can be set to open at differential pressure from 5 psi to 45 psi.

When ordering, specify part number 695931 and set pressure.