BASIC OF FILTRATIONS

Filter Concept Pvt. Ltd.

(An ISO 9001:2008, ISO 14001:2004, OHSAS 18001:2007 ASME 'U' & 'UM', The

National Board Of Boiler & Vessel Inspectors 'R' & 'NB' Certified Company)

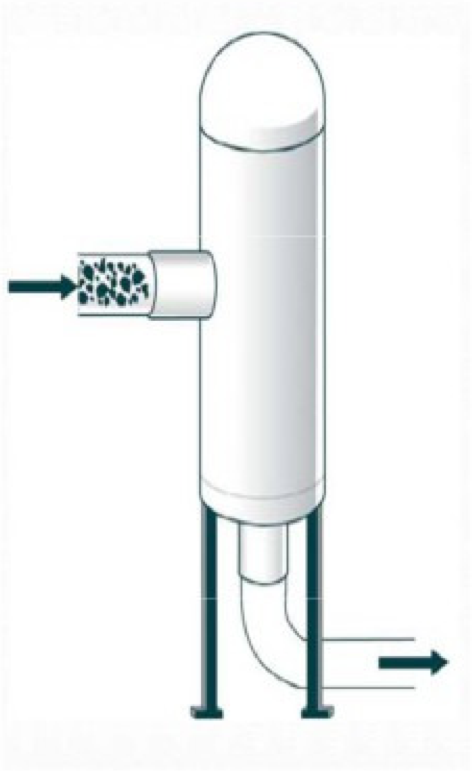
Basic Of

Filtrations

Reasons For Filtration

Removal of fluid contaminants

- Eliminate costly problems
- Filtered product more valuable
- Increase product yield



Collection of suspended solids

- Catalysts recovery
- Reduce operating cost

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Filtrations

Driving Forces

Filtration

The removal of a suspended particles from fluid, liquid or gas by passing a fluid through a porous or semi-permeable medium

Separation

The removal of dissolved substance from a carrier fluid stream

Cartridge filtration

Pressure driven

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Filtrations

Other Driving Forces

- Gravitational
- Settling
- Centrifugal
- Vacuum

Advantages

- Greater output
- Small equipment required
- Ease in handling volatile liquids

Pressure Drop

- System pressure drop
- Cartridge pressure drop
- Housing pressure drop

Filtration Variables

- Flow rate
- Differential pressure
- Viscosity
- Contaminants
- Flow conditions
- Compatibility
- Area

Flow Rate

- **Size determined by the cartridge**

  In most of the cases, the flow rate and /or capacity needs of the application will be used to determine the appropriate size of cartridge. The housing will then be sized to fit the selected Cartridge

- **Inlet /Outlet**

  The inlet /outlet pipe size is also selected to meet the flow rate requirement. In most cases this is already determined by the pipe size in the system

Differential Pressure

- Difference in pressure between the inlet & outlet sides of a filter
- Measured as PSI or kPa and referred to as PSID ΔP, pressure drop or differential pressure
- For applications sensitive to pressure drop, housing & cartridge need to be considered

$$\Delta P = \Delta P \text{ Cartridge} + \Delta P \text{ Housing}$$

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Location

- The size of the housing may be influenced by the amount of space available for the installation
- Location and product selection can also be influenced by the surrounding environment

Dirt Holding Capacity

Dirt holding capacity is measure of the weight gain of a filter during its useful (as measured by pressure drop at a given flow rate) life.

Basic Of Filtrations

Systems

Open

- Effluent to atmosphere

Parallel

- Two or more systems
- Higher flow rates
- Reduced pressure drop

Series

- Two or more systems
- Step filtration

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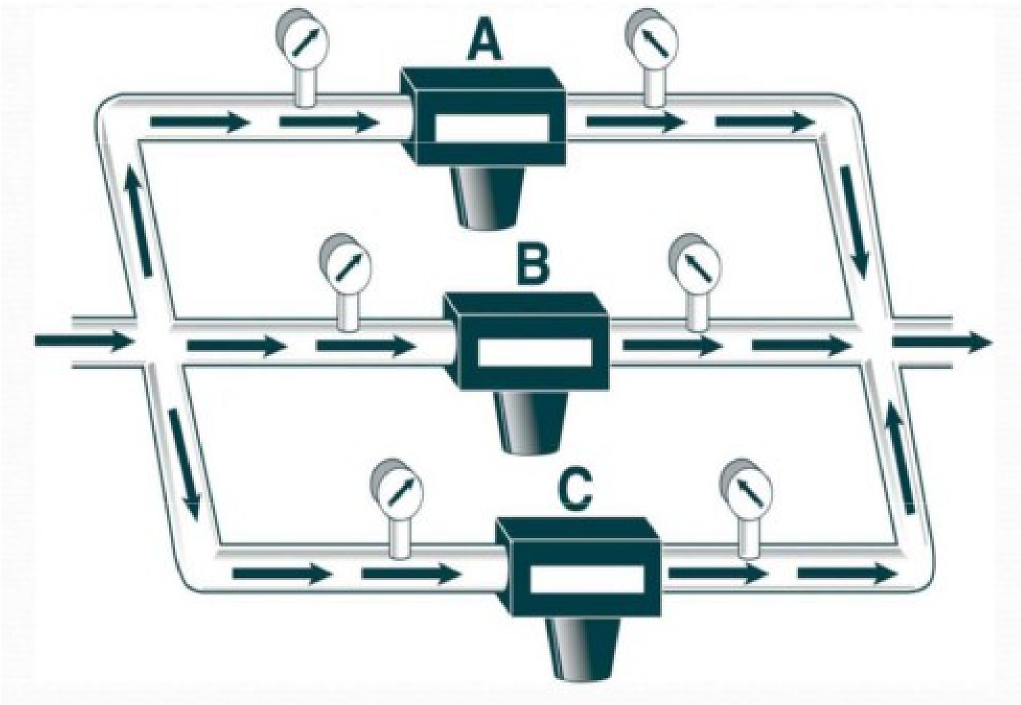
Filtrations

Parallel System



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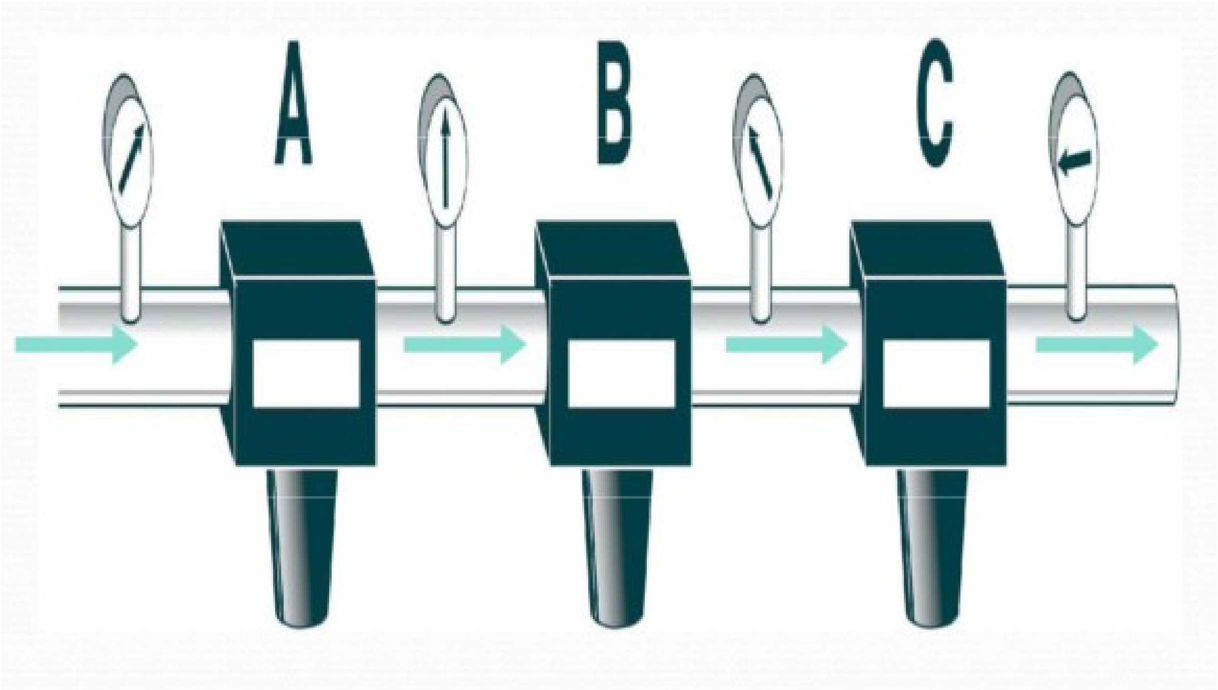
Series System



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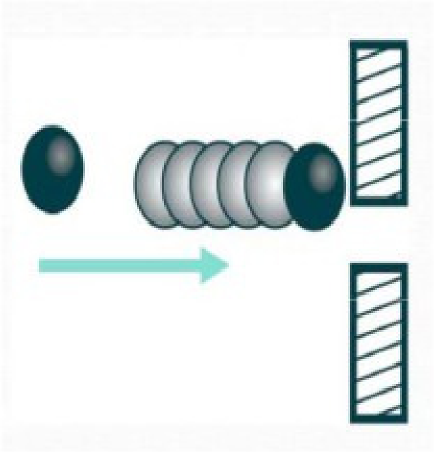
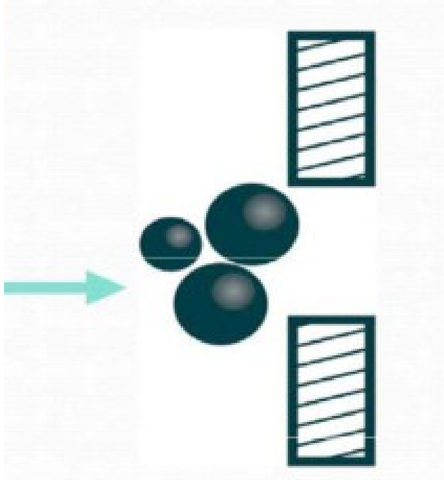
Filtrations

Mechanical capture

Direct interception

Physical barrier capture





Bridging

Two particles hitting the filter medium at the same time creating a smaller pore

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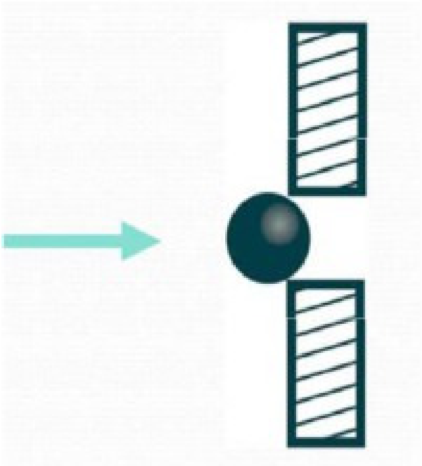
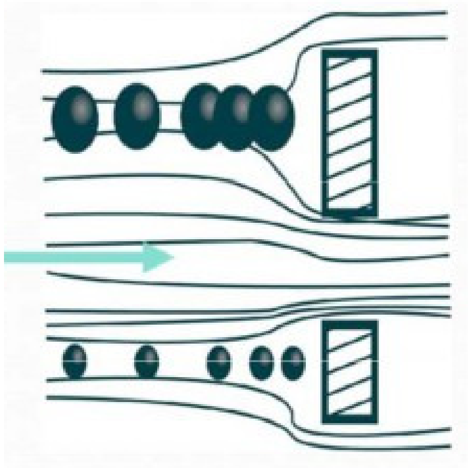
Filtrations

Mechanical Capture



Sieving

Particle too large to pass through pore



Inertial impaction

Inertia principle

Diffusion interception

Primarily found in gases

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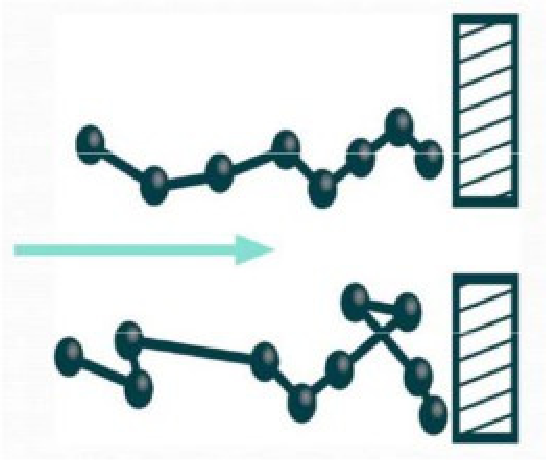
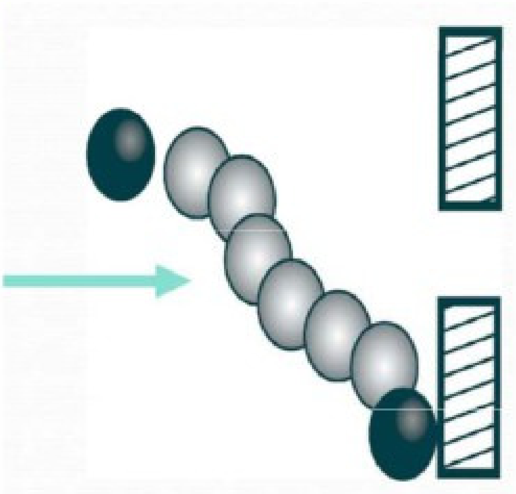
Mechanical Capture

Electro kinetic effects

Electrically charged filter medium





Gravitational settling

Heavier particles settled at bottom

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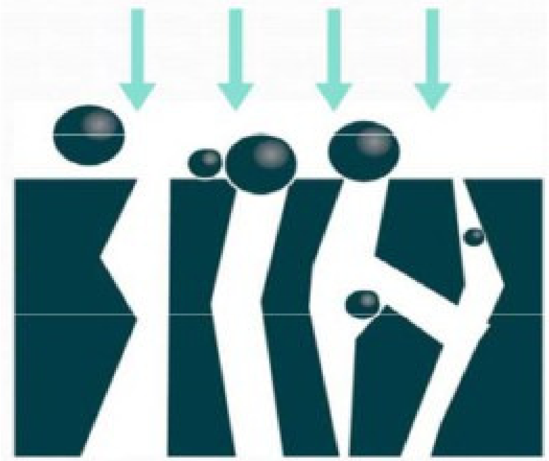
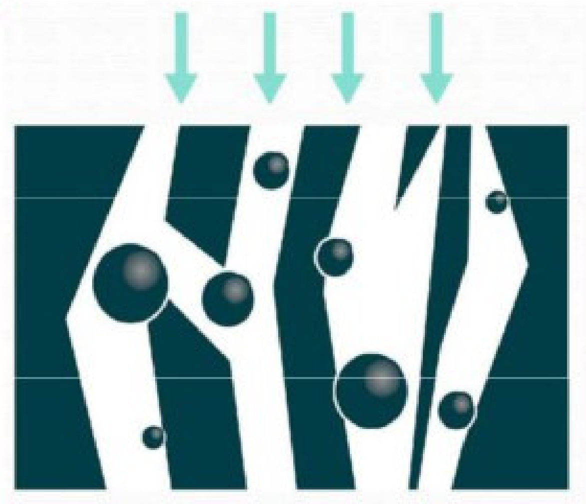
Means Of Retention

Mechanical retention

Particle restriction from passing through medium





Adsorptive retention

Adherence of particles to medium

Media Migration & Particles Migration

- ***Media migration*** is the sloughing of the filter medium into the filtered fluid

- ***Particle migration*** is the sloughing of filtered particulate matter from the filter cartridge into the filtered fluid. This occurs most often due to changes in the flow rate or excessive pressure drop

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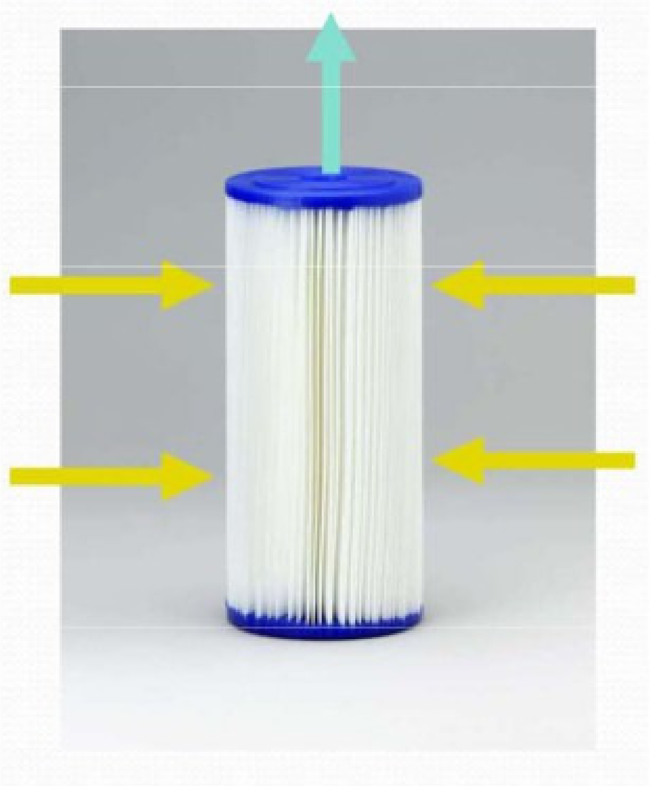
Cartridge flow

Radial flow

- Pleated
- String wound
- Polypropylene spun
- Paper carbon
- Carbon black
- Granular Carbon
- Specialty



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Cartridge Flow

Up flow

- Granular carbon
- Specialty
  - ¾Softener
  - ¾DI
  - ¾Iron reduction

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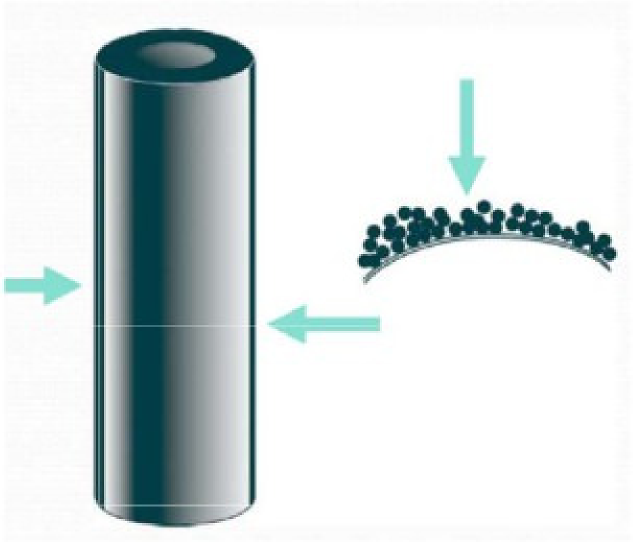
Means of retention

- Surface
  - ¾Particles on the surface of medium forming a cake



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Surface filters

- Surface filters remove particulate matter via a sieving mechanism. (you can't push a basketball through chicken wire.)
- The media is usually pleated to provide the maximum amount of surface area.

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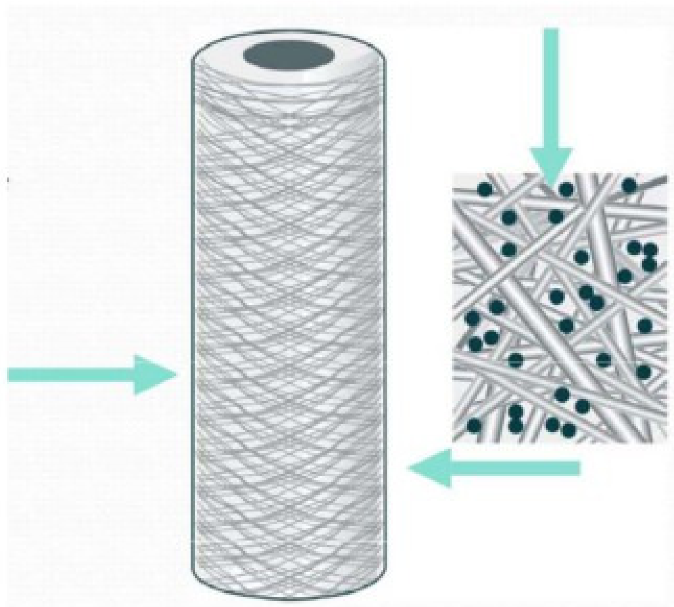
Means of retention

•Depth

¾Particles trapped throughout the depth of medium



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Depth Filters

•Depth filters remove particulate matter via a tortuous path. The fluid travels racially through the depth of the cartridge.

•Depth cartridges normally have a graded density. They have larger openings at their surface and smaller openings near their center.

Surface vs. depth filters

- *In theory* ***a surface filter*** will work better when the particulates matter in the water are of the same size.

- ***A depth filter*** will work better when the particulate matter has abroad range of sizes and the filter truly has gradient density.

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Filtrations

Performance Factors

- Filtration efficiency and micron rating
- Dirt holding capacity
- Pressure drop
- Media migration & particles migration
- Chemical compatibility

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Parameter	Surface Filters	Depth Filters
Deformable Particles	May blind off pleats	Recommended-Adsorptive retention
Non-deformable Particles	Removes narrow range	Removes broader range of particles
Rating	Absolute or nominal	Absolute or nominal
Classification/ Clarification	Classification	Clarification
Flow per 10 equivalent PSID	Recommended 10 gpm	Recommended 5 gpm
Economics-Particle Retention < 10 micron	Holds more dirt than depth, handles higher flow rate	More economical than pleated at greater than 10 microns
Cartridge Cost	More expensive initially than depth, fewer replacements, holds more dirt	More economical initially than pleated, holds less dirt
Housing Cost	Fewer cartridges-smaller housing	More cartridges-bigger housing

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Type of cartridge	Description	Benefits	Typical Application
Yarn Wound (Depth)	Yarn of twisted staple fibers wound around a center core .	Inexpensive, broad chemical compatibly, numerous material options for many applications.	Chemicals, magnetic coatings, Cosmetics ,oil production ,food and beverages ,potable water ,photographic applications
Non -Woven (Depth)	Depth media crated by layering melt brown (extruded) fibers	Graded pore structure, chemically inert materials , No extractable downstream.	Photo chemical ,potable water, solvents , ultrapure water ,chemicals , beer & wine, food and beverages enzymes, resins
Non - Woven Pleated (Surface)	Pleated media ;spun bonded or melt brown sheets ,paper like	Wide chemical compatibility ,large surface area per 10” cartridge, high dirt holding capacity ,cheaper than depth , cartridge at low microns	DI water , Process water, electronics , wine filtration ,photographic applications, magnetic coatings, chemical s, cosmetics.
Membrane	Polymeric sheets containing symmetric or asymmetric pores (RO membrane and most UF membranes don’t have pores)	Asymmetric pores , Positive mechanical retention, high flow rate, absolute ratings ,resistance to bacteria, ultra -fine filtration	DI water applications, electronics ,plating, chemical process ,power generation, photo graphic applications, food and beverages, various etch baths.

Basic Of Filtrations

Type of cartridge	Description	Benefits	Typical Application
Resin - Bonded	Fibers Treated with resin to enhance rigidity	Rigid for high viscosity, no center core, no glues or epoxies, little media migration, one piece construction , high flow rates	Paints ,inks ,coatings ,adhesives, oils ,sealants, resins , petroleum, Pesticides, salt water, varnishes
Sintered Metal	Porous media formed by sintering thin layer of metal	Absolute rating, strength, porosity, Clean ability , high flow and dirt holding capacity ,non fiber releasing	High temperature, high pressure applications , corrosive fluids, polymer filtration ,process steam, gas filtration , catalyst recovery
Woven Metal	Fibrous media woven into distinct pattern	Strength, clean ability, high flow porosity, dirt holding capacity	Same as Dynalloy but at much larger micron ratings. Used more as s sieve
Granular	Porous carbon activated to develop large surface area	Removes dissolved organics from gas and liquids	Potable water , reverse osmosis ,organic removal , instrument sir plating solutions .

Basic Of

Filtrations

Fiber filtration

•Fiber diameter

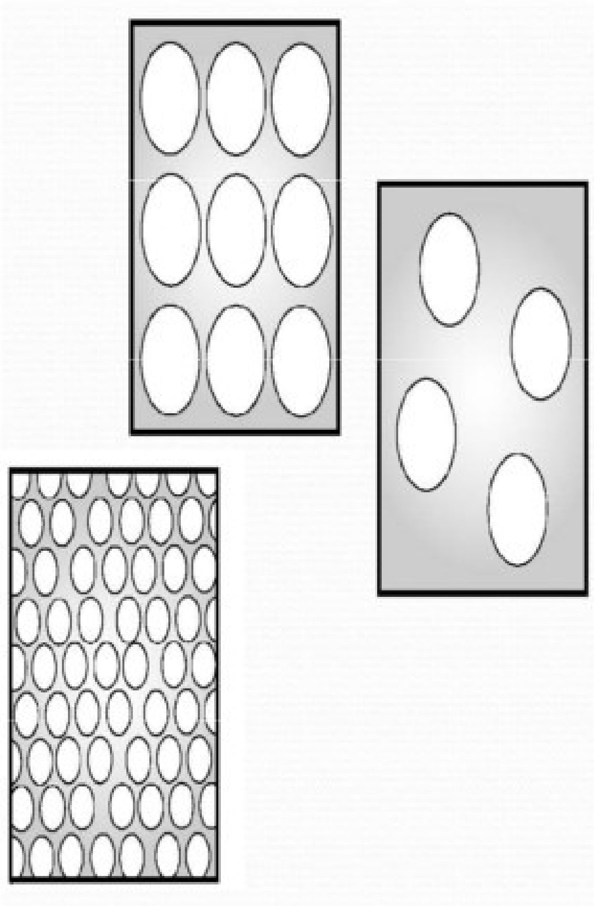
Thinner fibers equal finer filtration

•Porosity

Ratio of void volume to total volume of medium

•Thickness of media

Thicker medium equals decreased pore size



Industrial water requirement

Product	Unit Produced	Gal./Unit	Water required /Gal./Day
Buildings			
Office	Person	-	27 to 45
Hospital	Bed	-	130 to 350
Hotel	Guest room	-	300 to 525
Laundries			
Commercial	1b. Work load	5 to 8	-
Institutional	1b. Work load	1 to 4	-
Restaurants	Meal	1 to 4	-
Meat			
Packing house	100 hogs killed	550- 600	-
Slaughter house	100 hogs killed	550-600	-
Stockyard	1 acre	160-200	-
Poultry	1 Bird	-	1
Oil			
Oil Refining	100 bbl	75000 to 80000	

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Product	Unit Produced	Gal./Unit	Water required /Gal./Day
Sugar			
Sugar Refinery	1b. Sugar	1	-
Paper			
Paper mill	1 ton	40,000	-
Paper Pulp			
Ground wood	1 ton (dry)	5000	-
Soda	1 ton (dry)	85,000	-
Sulfate	1 ton (dry)	65,000	-
Sulfite	1 ton (dry)	60,000	-
Textile			
Cotton Bleacheries	1 lb.double boil	25 to 40	-
Cotton finishing	1 Yard	10 to 15	-
Silk Hosiery dyeing	1lb.	3 to 5	-
Knit goods bleaching			

Chemical compatibility

Several sources are available to check the compatibility of housings for use with fluids other than water.

Remember to check all materials in the cap, sump, O-ring, and cartridge.

Chemical	Temp	% Conc.	PP TP	SAN	Nylon GP	ABS GP	Delrin	Buna-N	Silicone	Viton B-60	300 Series SS
Acetic Acid	125	90	A	A	D	A	D	C	-	C	-
Acetone	125	100	A	D	B	D	B	D	B	D	A
Ammonium Compounds	125	100*	A	A	A*	A	B	A	B	A	C
Ammonium Hydroxide	125	10	A	A	A	A	D	A	-	A	C
Beer	125	Any	A	A	D	B	A	D	C	A	A
Benzene	72	100	B	D	A	D	B	D	-	A	B
Calcium Compounds	125	Any*	A	A	A	A	A	A	C	A	B/C
Calcium Hypochlorite	68	20	A	-	D	-	D	B	C	A	D
Citric Acid	125	10	A	A	C	B	A	D	C	A	-
Cottonseed Oil	125	-	A	A	A	B	A	A	-	A	B
Detergents	125	2	A	A	A	A	A	A	-	A	-
Ethyl Alcohol	125	96	A	B	A	B	A	A	B	A	-
Freon	68	25	B		A		D		D		
Fruit Juices	125	-	A	A	A	A	A	A	-	A	A
Gasoline	125	100	C	A	A	D	B	A	D	A	A
Glucose	125	20	A	A	A	A	A	A	B	A	A
Glycerin	125	100	A	A	A	B	A	A	B	A	A
Glycol	125	-	A	D	-	D	A	A	-	A	-
Hexane	125	100	C	-	A	D	D	A	B	A	A
Hydrochloric Acid	125	20	A	A	D	B	D	C	-	A	-
Hydrofluoric Acid	68	40	A	-	D	A	D	D	-	A	-

Chemical	Temp	% Conc.	PP TP	SAN	Nylon GP	ABS GP	Delrin	Buna-N	Silicone	Viton B-60	300 Series SS
Hydrogen Peroxide	68	30	A	-	D	-	D	D	-	A	-
Inks	125	-	A	B	A	B	A	A	-	A	A
Ketones	68	-	D	D	B	-	C	D	-	D	A
Lubricating Oils	125	100	C	A	A	B	A	A	C	A	A
Mercury	125	100	A	-	A	-	A	A	-	A	A
Methyl Alcohol	125	100	A	D	A	D	A	B	-	C	-
Mineral Oil	100	100	B	A	A	A	A	A	-	A	A
Naphthalene	125	100	A	B	A	C	D	B	D	A	A
Nitric Acid	68	10	A	B	D	C	D	D	-	A	A
Olive Oil	125	100	A	A	A	A	A	A	C	A	A
Plating Solutions	125	-	A_	-	A/D*	-	-	A_	D	A	-
Sodium Compound	125	Any	A	A	A/C*	C	-	A	C	A	B
Sodium Hypochlorite	100	5	A	A	A	B	A	A	C	A	B
Sugar & Syrups	125	-	A	-	A	B	A	A	A	A	A
Sulfuric Acid	68	25	A	A	D	B	D	C	-	A	-
Toluene	100	-	D	D	A	D	D	D	D	C	A
Water (hot)	200	100	-	-	A	-	-	C	A	B	A
DI Water	125	100	B	A	A	A	A	A	A	A	-
Sea Water	125	100	A	B	A	A	C	A	-	A	-
Whiskey/ Wine	125	-	A	A	A	A	A	A	-	A	A
Xylene	100	100	C	D	A	D	D	D	D	A	A

Temperature

- Standard polypropylene housings have a maximum temperature rating of 125℉ (52℃).
- Glass reinforced nylon housings have a maximum temperature rating of 165℉ (74℃).
- All Housings should be protected from freezing.

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Filtrations

Temperature

Gasket Material	Buna - N	250˚ F (121˚C)
	Ethylene Propylene	350˚ F (177˚C)
	Viton	450˚ F (232˚C)
	Teflon	500˚ F (260˚C)
Filter Media	Polyester	300 ˚F (149˚C)
	Polypropylene	200˚ F (93˚C)
	Nylon	300˚ F (149˚C)
Housing media	Carbon Steel	300˚ F (149˚C)
	304 Stainless steel	300˚ F (149˚C)
	316 Stainless steel	300˚ F (149˚C)
	PVC	150˚ F (65˚C)
	Polypropylene	125˚ F (52˚C)

Filtration efficiency and micron rating

- There is a big difference between absolute and nominal rating
- In most cases a nominally rated filter is adequate.
- A filter's efficiency is the percentage of particles of a specific size (microns) that it will remove
- Filter efficiency is dependent on flow rate
- *A **nominal micron** rating is generally accepted to mean the particle size at which the filter is **85%** efficient*
- *An **absolute micron** rating is generally accepted to mean the particle size at which the filter is **99.99%** efficient*

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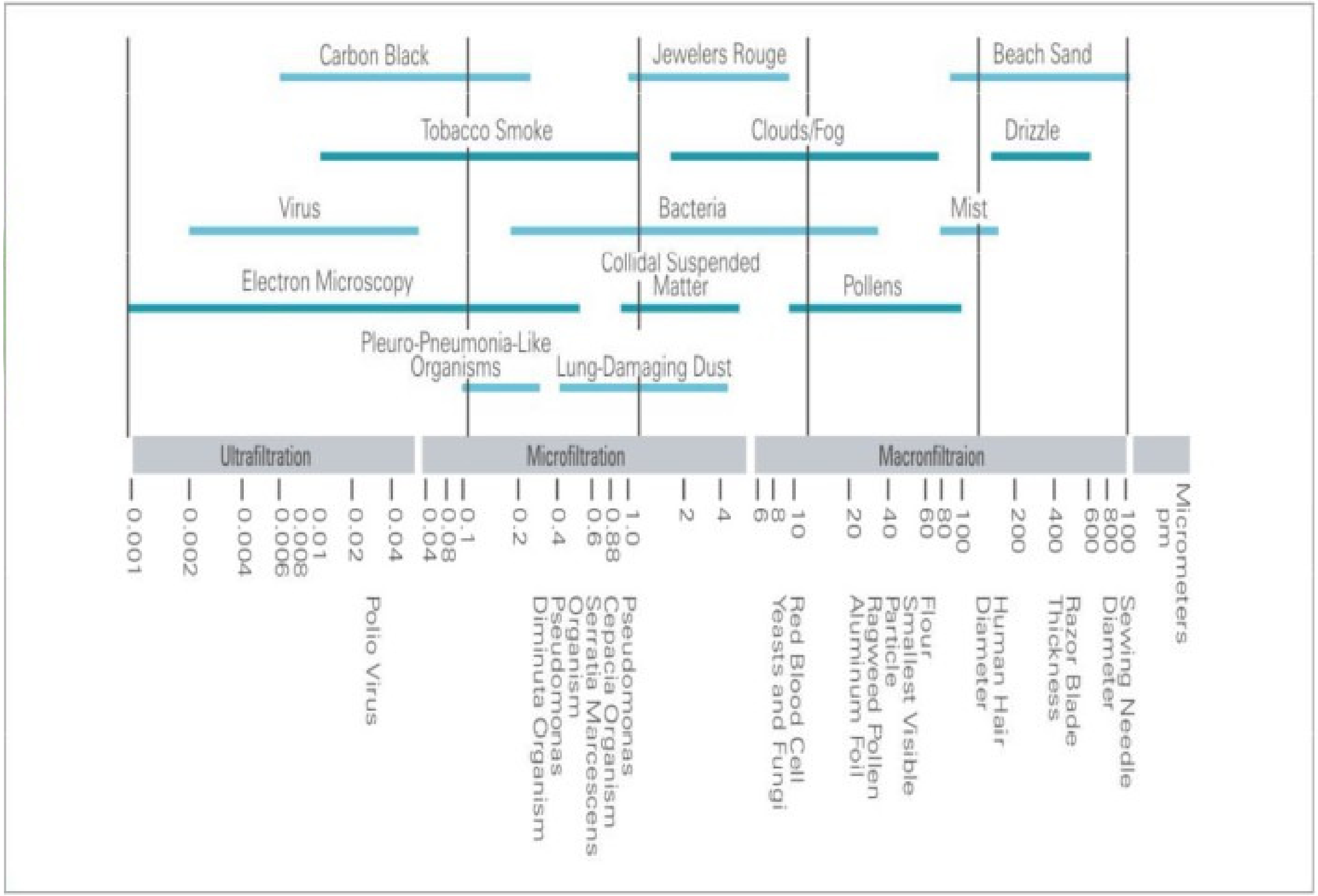
Relative sizes of particles



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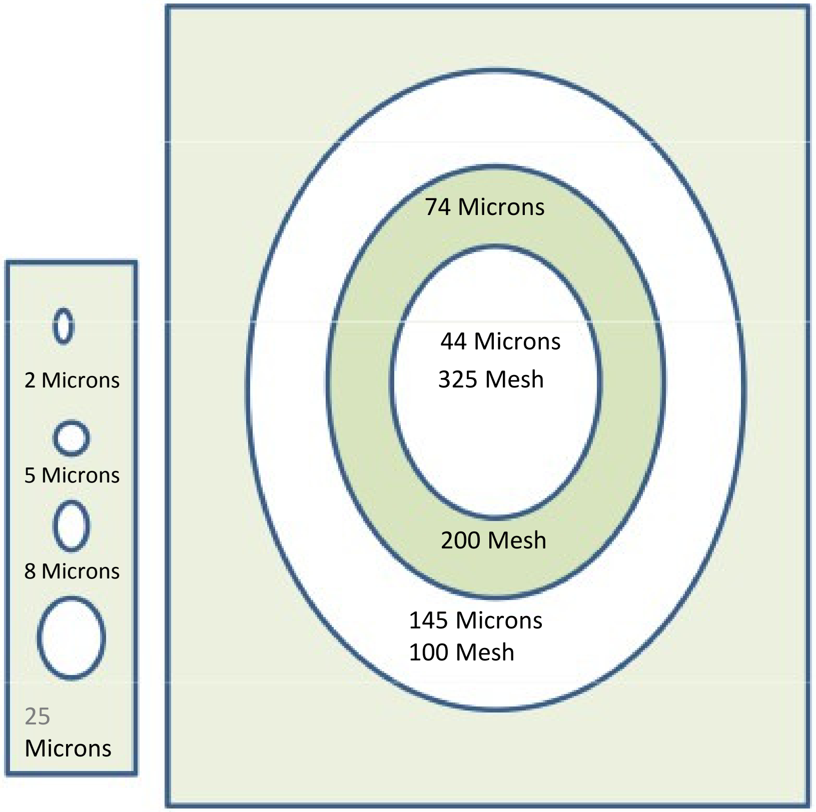
Micron Size

Particle	Size
Table salt	100 microns
Human Hair	40- 70 microns
Talcum Powder	10 microns
Fine test dust	0.5- microns
Pseudomonas diminuta	0.3- microns



Magnified 500 times

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Filtrations

Filter Efficiency

- A filter's efficiency is a function of the beta ratio

Beta ratio	% Efficiency
1	0
2	50
4	75
5	80
10	90
20	95
50	98
75	98.67
100	99
1000	99.9
5000	99.98
10000	99.99
Infinity	100

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