

FIBRE FILTRATION PRINCIPLES & FILTRATION VARIABLES

FIBRE FILTRATION PRINCIPLES

Pore size of the filter is the most important consideration when choosing a cartridge. Pore size is dependent on the following:

FIBRE DIAMETER

As fibre diameter decreases, mean pore size decreases. In other words, in order to get a finer filter, use thinner fibres.

POROSITY

Porosity is the ratio of the void volume to the total volume of a filter medium. Porosity can be decreased by winding a cartridge more tightly. Decreasing the porosity decreases the mean pore size and makes the filter finer. However, decreasing the porosity also increases the resistance to flow of the cartridge, consequently increasing the overall ΔP .

THICKNESS OF THE FILTER MEDIA

As filter medium becomes thicker, mean pore size decreases and as layers of medium are added to a cartridge, the pores become smaller. However, as with the case with porosity, adding layers to the medium increases the resistance to flow and, consequently, the overall ΔP .

*NOTE: DESIGNING A FIBROUS FILTER IS A JUGGLING ACT BETWEEN FIBRE DIAMETER, POROSITY AND THICKNESS OF FILTER MEDIUM.

FILTRATION VARIABLES

Filtration performance (life and efficiency) varies as operating conditions change. The guidelines described below are a basic outline of how operating conditions affect filter life and efficiency.

EFFECT ON EFFICIENCY

1. **Flow Rate** - High flow rates are detrimental to adsorptive retention mechanisms and, hence, decrease efficiency. This effect is more dramatic in wound cartridges and at higher micron ratings. Conversely a decrease in flow rates increases efficiency by enhancing adsorptive retention and

the ability to form a filter cake. Some evidence suggests that optimum efficiency occurs around 0.5 to 0.75 GPM/12 ft for pleated media.

2. **Differential Pressure** - In order to maintain a constant flow rate through a filter as it plugs with contaminant, more fluid must flow throughout the progressively smaller unplugged portions of the cartridge. This increases differential pressure and decreases efficiency.

*NOTE: IF THE DIFFERENTIAL PRESSURE IS ALLOWED TO EXCEED THE MANUFACTURER'S RECOMMENDED MAXIMUM, TYPICALLY 35 PSID, BOTH THE LIFE AND EFFICIENCY OF THE CARTRIDGE MAY BE COMPROMISED.

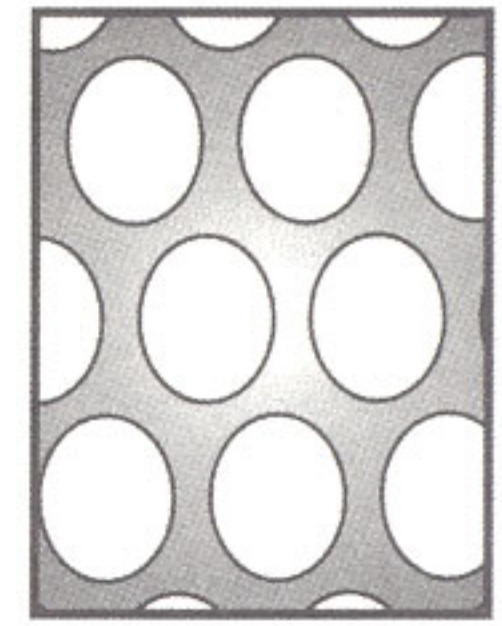
3. **Viscosity** - Increasing viscosity increases the hydrodynamic drag of the fluid and also increases the differential pressure required to push the liquid through the filter. Increasing the viscous drag is detrimental to adsorptive retention, consequently decreasing filter efficiency.

4. **Contaminant** - The relationship of particle size distribution to pore size determines the degree of surface versus depth filtration.

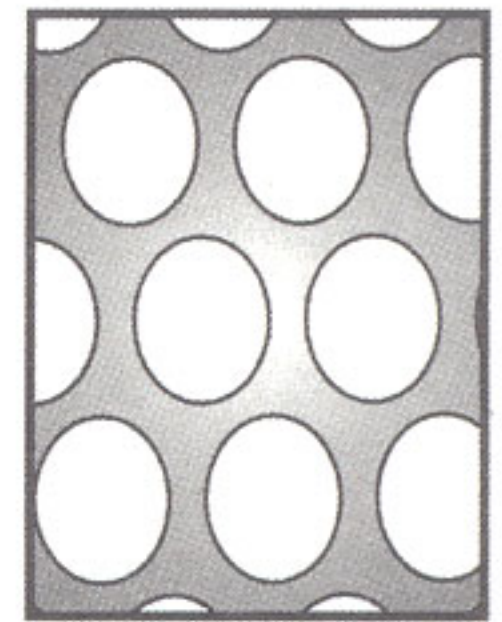
5. **Flow Conditions** - Cartridge filters are designed for use under steady flow conditions. Pulsating flow can disrupt a filter cake and/or dislodge particles that were adsorptively or even mechanically retained. Excessive pulsing can also cause structural damage to the filter.

6. **Compatibility** - Fluids that are not compatible with a filter can have various detrimental effects on filtration efficiency. Incompatibility can cause filter media to swell, become brittle, dissolve, shrink and separate from end seals and release fibres. The filter may become seriously weakened.

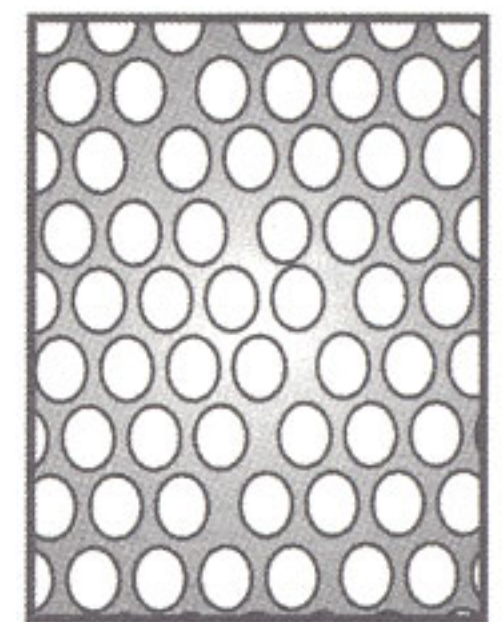
7. **Area** - Increasing filter area while keeping the flow rate constant reduces the flux or flow density (flow rate per unit area) and, therefore, increases filter efficiency.



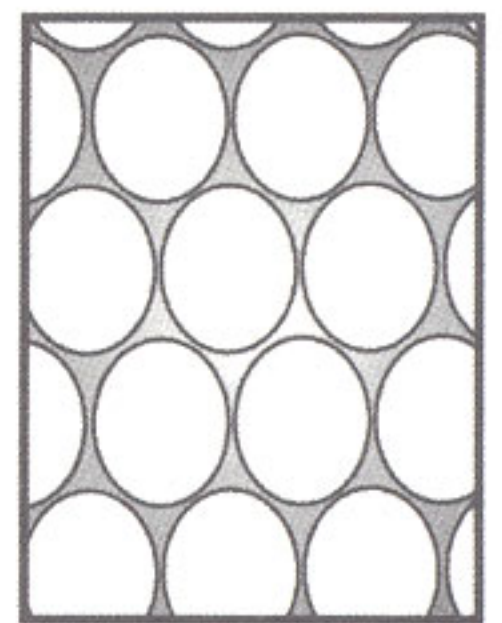
PORE SIZE



HIGHER POROSITY



PORE SIZE



LOWER POROSITY:
MORE FLOW RESISTANCE

FIBRE FILTRATION PRINCIPLES - CONTINUED

EFFECT ON LIFE

1. **Flow Rate** - Increasing flow rate decreases the life of the filter. Conversely, decreasing flow rate increases the life of the filter. This is largely due to increased bridging of pores near the upstream surface of the filter and premature plugging of the filter medium.
2. **Differential Pressure** - It is recommended by most manufacturers that filters be changed out at a terminal ΔP value. Filter life can be maximized by starting out with a low initial ΔP , thereby allowing more of a buildup to reach terminal ΔP .
3. **Viscosity** - Increasing viscosity increases the differential pressure required to push the fluid through a filter. A higher initial PSID means less on-stream life until terminal PSID is reached.
4. **Contaminant** - If the following conditions are met:
 - a) a nondeformable irregularly shaped solid builds a noncompressible cake, b) the filter cake does not become a finer filter than the medium itself, and c) the collected solids are relatively uniform in particle diameter, then cartridge life will be maximized and approach the relationship:

$$\text{Change In Filter Life} = (\text{Change In Effective Filter Area})^2$$

5. **Flow Conditions** - Steady flow conditions promote the accumulation of a filter cake which increases service life. Pulsating conditions can disperse the cake, temporarily lowering PSID until the cake builds up again or prevent the formation of a filter cake at all.
6. **Compatibility** - Compatibility problems have a detrimental effect on efficiency. If efficiency is seriously affected, filter life is irrelevant.
7. **Area** - Increasing filter area directly increases filter life, up to a point. Doubling the filter area can increase filter life up to four times (minimum of two times), but there is a practical limit to the amount of filter media that can be packed into a cartridge. Beyond this optimum area, diminishing returns in life can be expected. For this reason, comparisons of cartridges made with different media on the basis of area alone can be misleading.

CARTRIDGE FILTER CONFIGURATIONS

Cartridge filters are available in a variety of different configurations. The chart on the following page summarizes different types of cartridge filters and lists examples within the Filterite product line for each one.

VARIABLES OF FILTRATION SUMMARY

VARIABLE	CARTRIDGE EFFICIENCY	CARTRIDGE LIFE
Flow Rate	Decrease Flow = increase efficiency	Decrease flow = increase life
Differential Pressure (PSID)	Decrease PSID = increase efficiency	Decrease PSID = increase life
Viscosity	Decrease viscosity = increase efficiency	Decrease viscosity = increase life
Contaminant	Dependent on pore/particle size relationship and contaminant type	Nondeformable particles promote formation of life extending filter cake
Flow Conditions	Pulsing/surging is detrimental	Steady flow promotes filter cake formation = longer filter life
Chemical Compatibility	Incompatibility threatens efficiency	Incompatibility threatens life
Area	Increase area - increase efficiency	Increase area = longer life

