

## SURFACE VERSUS DEPTH FILTRATION

The terms "surface filtration" and "depth filtration" describe parameters of the particle size/pore size relationship present during the filtration process. Although filters are often generalized as being surface or depth filters, in reality, the label is inappropriate unless the particle size/pore size relationship is known.

### SURFACE FILTRATION

A true surface filter can be thought of as a screen that is challenged with particles that are too large to pass through its openings. The particles will collect on the surface, forming a filter cake. Retention will be absolute since no particles will be able to penetrate through the surface. The mechanism of capture is recognized as sieving. Note, however, that if the same screen is challenged with small enough particles, it would no longer capture all of the contaminant's at the surface. Hence, the process of surface filtration is strictly dependent upon the particle size/pore relationship.

### SIEVE RETENTION: UNIFORM PORE SIZE

Pleated filters are designed to enhance surface filtration when appropriately utilized. The micro-fibre sheet media has a narrow pore size distribution, favoring absolute sieving, in addition to a large surface area, increasing the capacity to retain particles at the surface. The medium is thin, permitting higher flows with lower pressure drops. These properties promote the formation of a filter cake, giving this type of filter a high dirt holding capacity.

### DEPTH FILTRATION

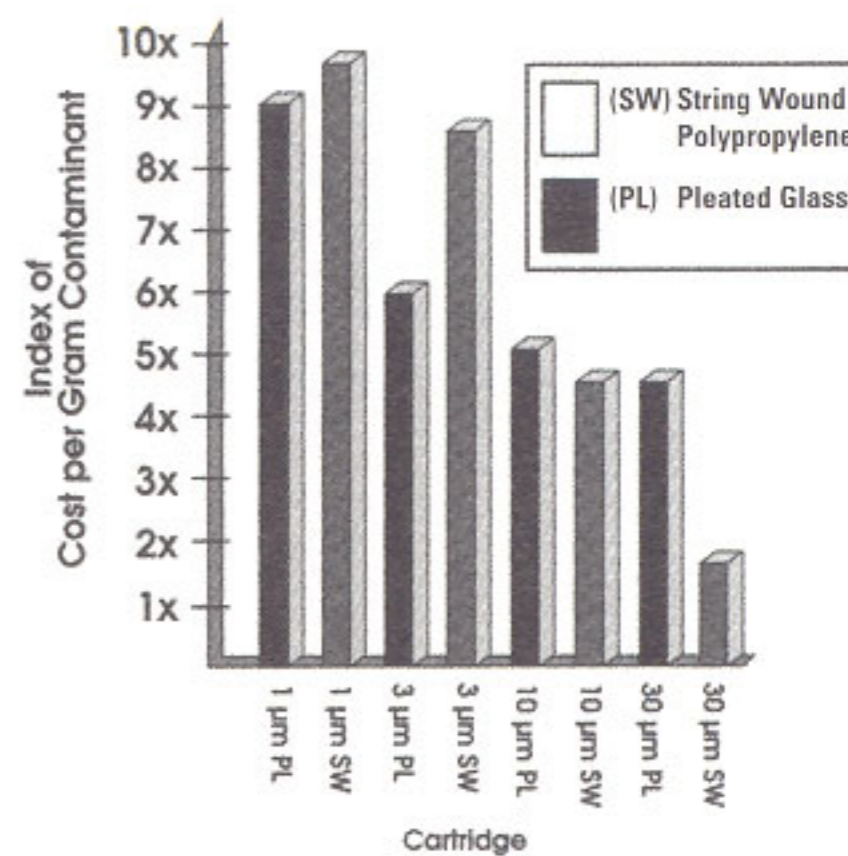
A true depth filter allows particles to penetrate the filter matrix and become captured throughout the depth of the medium. As with surface filtration, this only holds true when the particle size/pore relationship is conducive to the process for which the cartridge was designed.

The depth filter matrix has a broad pore/size distribution; hence, depth cartridges rely on adsorptive retention for a portion of their dirt-holding capacity. Some depth filters, such as the ARD, Nexis and DFT Classic, have a gradient pore structure, with tighter pores near the centre core, to maximize mechanical retention. In some depth cartridges, such as string wound, the medium is not a fixed pore matrix, as with chemically or thermally affixed pleated media. For this reason, depth cartridges should not be subjected to flows as high as those that are possible for pleated cartridges.

Most depth filters are made from extruded melt down fibres or twisted yarn fibres. Melt down depth fibres are generally made from polypropylene, polyester or nylon and can be made in both absolute and nominal retention ratings. These types of cartridges can be made to filter particle sizes from less than one micron to over 100 microns. Yarn wound cartridges, made with fibrous materials, are often brushed in order to maximize the tortuosity of flow through the fibre. They are nominally rated but offer the advantage of being made from a variety of materials.



MECHANICAL  
RETENTION



**SURFACE VERSUS DEPTH FILTRATION - CONTINUED**

thereby "classifying" the particles of the fluid. Hence, the term classification is used to describe the filtration performance of a pleated or surface filter.

The surface cartridge illustrated in the graph has a one micron absolute rating. The slight removal of particles under one micron in size is due to the fact that some smaller particles penetrated the depth of the medium and were adsorptively retained or became captured in the filter cake.

**FLOW RATES/PRESSURE DROPS**

Pleated filters can be subjected to higher flows than depth filters and will have lower initial pressure drops.

If there is a question as to whether depth or pleated cartridges should be used, one could size the system for both and determine which would be more economical.

**NOMINAL VERSUS ABSOLUTE**

Surface and depth cartridges can be given both absolute and nominal ratings. Membrane cartridges are given absolute ratings. Retention ratings refer to the size of the particles retained rather than the average size of pores in the filter.

There are no industry standards for the assignment of retention ratings and numerical definitions of nominal and absolute differ from company to company. The only way to investigate the true meaning of a nominal or absolute rating is to study the test procedures from the filter manufacturer. Filterite life and efficiency test procedures are illustrated in Bulletin 1903-T.

**Nominal:** A measure of retention, expressed in microns, that specifies the equivalent diameter of the smallest particle for which the filter has a retention of 90% (for Filterite). Other manufacturers may use a different percentage.

**Absolute:** A measure of retention, expressed in microns, that specifies the equivalent diameter of the smallest particle for which the filter has a retention of 100%. In actual practice, most manufacturers assign absolute ratings on the basis of retention in the range from 98%-99.999999%. Filtrite uses the figure 99.9% for an absolute rating.

**RECOMMENDED FLOW RATES**

CARTRIDGE TYPE	RECOMMENDED FLOW	MAXIMUM FLOW
Pleated	5 GPM	10 GPM
Membrane	5 GPM	10 GPM
Depth	2.5 GPM	5 GPM

**SUMMARY OF DEPTH VERSUS PLEATED FILTERS**

PARAMETER	SURFACE FILTERS	DEPTH FILTERS
Deformable Particles	May blind off pleats	Recommended – Adsorptive retention
Nondeformable 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 microns	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

\*BASED STRICTLY ON CARTRIDGE PURCHASE. PLEATED CARTRIDGES COST MORE PER 10" EQUIVALENT. IF A NEW SYSTEM IS BEING DESIGNED, A LARGER HOUSING WILL BE NECESSARY FOR DEPTH CARTRIDGES, AS OPPOSED TO PLEATED CARTRIDGES, TO ACHIEVE THE SAME FLOW AT A GIVEN PRESSURE DROP AND MICRON RATING.



**SURFACE VERSUS DEPTH FILTRATION - CONTINUED**

**DEPTH VERSUS SURFACE**

Descriptions of depth filters and surface filters usually emphasize extreme characteristics of each. In reality, the filtration process is somewhere on a scale between the two, leaning predominantly to one end or the other. The filter chosen to perform the task will dictate whether or not surface filtration or depth filtration will predominate. The debate of depth filter versus surface filter often becomes a complex issue that is dependent upon many different factors.

**ECONOMICS**

Generally pleated cartridges cost more per 10" equivalent than do depth cartridges. However, at the lower micron ratings, the higher cost of the cartridge is made up by the greater dirt holding capacity. A comparison of cost and dirt holding capacity for wound cotton DFT Classics versus pleated Duo-Fines was made to determine which is more economical.

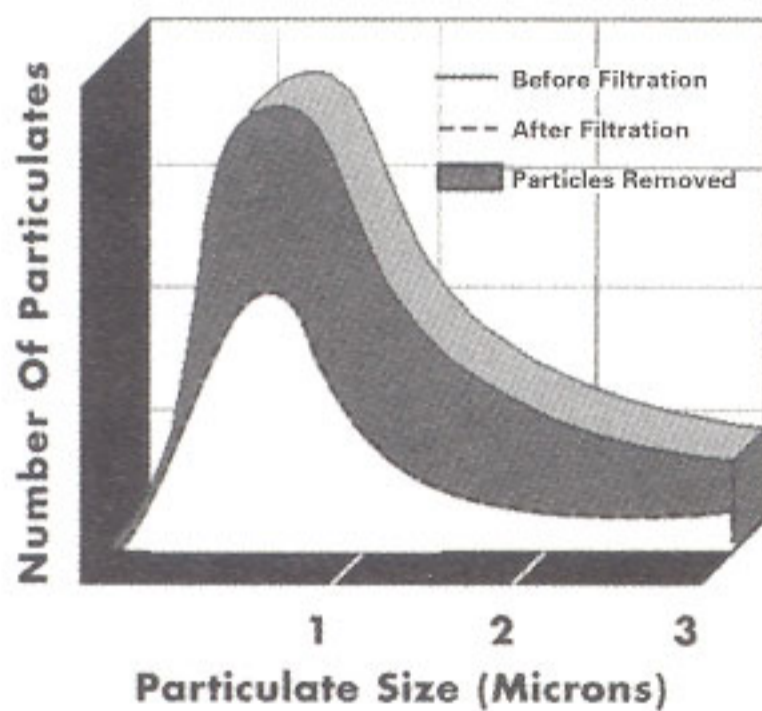
**COST PER GRAM OF CONTAMINANT**

The higher cost per cartridge of the pleated versus the wound levels out between 3 and 10 microns; below this point it becomes more economical to use pleated cartridges. Conversely, above this level, the wound cartridge is likely to be more economical. Keep in mind, however, that direct cartridge to cartridge replacement cost is not always the only governing factor. Consider an entirely new application in which a

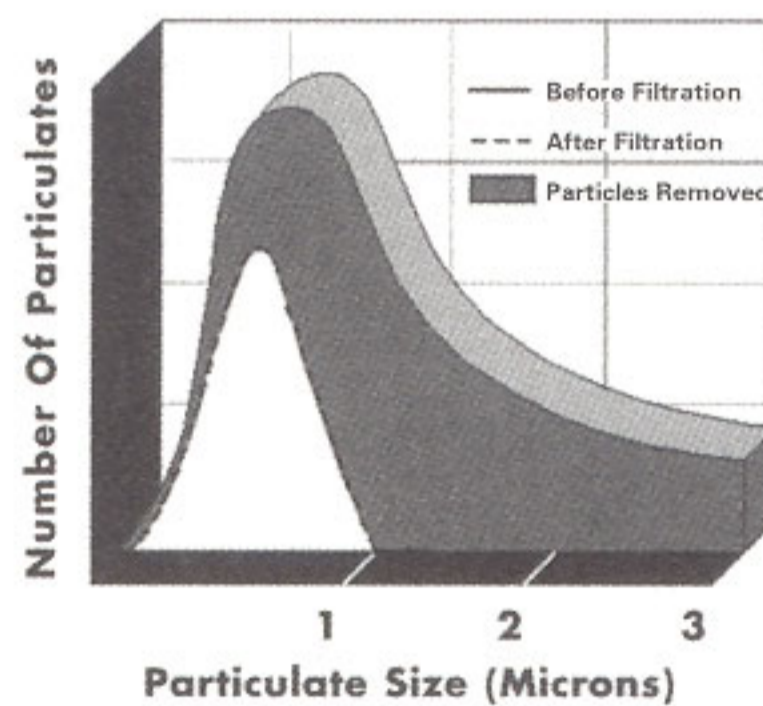
system has to be sized from flow data. Due to the ability of the pleated cartridge to flow at a higher rate with a lower PSID, fewer pleated cartridges would have to be incorporated into the system. This would require a smaller housing, fewer replacement cartridges and lower disposal costs. In this case, one would have to weigh the difference of the initial cost and cartridge replacement cost. For example, a 3 micron Duo-Fine cost three times more than a polypropylene DFT but holds 5.2 times the contaminant before reaching change out level.

**CLARIFICATION VERSUS CLASSIFICATION**

Due to the broad pore size distribution and the nature of removal with a depth cartridge, a broader range of particle sizes can be removed in comparison to removal with a pleated cartridge. The adjacent graph illustrates the performance of a depth cartridge when challenged with a log normal distribution. This type of removal is referred to as clarification and refers to the removal of a wide range of particle sizes. General removal of a broad range of particles is usually done by depth filters. Due to the narrow pore size distribution of pleated filters, removal is absolute above a specific rating and much less broad (in comparison to depth filters) for particles under that rating. The ideal removal performance for a surface filter is to retain all particles above a specific micron rating while passing all particles below that rating,



DEPTH FILTER



SURFACE FILTER

\*EVERYTHING ABOVE THE DOTTED LINE WAS REMOVED.



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