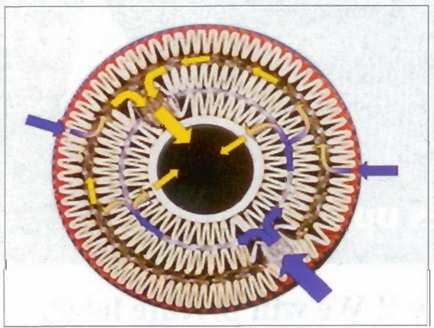
New Cartridge Filters Maximizes Filter Surface Area While Minimizing Diameter

By John Hampton, Filtration Technology Corporation

Filtration Technology Corporation has introduced two new cartridge filters that utilize patented design (U.S. Patent # 5824232) to maximize effective filter surface area while minimizing filter vessel diameter. This innovation in cartridge filtration can provide significant cost savings over many existing filtration products. The key to these cost savings stems from the unique design of the product, which utilizes segregated flow channels and flow chambers to maximize the effective surface area of the pleated filter media within each cartridge. Combining this design with the technique of pleating several different filter media together in a single pleat pack maximizes dirt-holding capacity. This design permits the use of many different types of filter media, which is essential for a wide range of fluid and temperature applications. The cross sectional view shown below details the basic design and flow paths of the filter.



Design and flow paths of the filter

FLOW PATTERN

Dirty fluid entering the filter (shown in blue) has two options:

1. Dirty fluid can go through the outer layer of pleats (as shown by the two smaller blue arrows), and the dirt is removed by the pleated media (as shown by the transitional blue to yellow arrows). The clean fluid (shown by the yellow arrows) then follows the clean flow chamber to the clean flow channel (shown in light brown) to the perforated core of the filter where it exits into the clean chamber of the filter housing.

2. Dirty fluid can go through the dirty flow channel (as shown by the large blue arrow) where it connects with the dirty flow chamber (as shown by the split blue arrow). Once inside the dirty flow chamber, the dirty fluid has the option of passing through the middle layer of pleats or passing through the inner layer of pleats. If the dirty fluid passes through the middle layer, the dirt is removed and the clean fluid enters the clean chamber and follows the path to the perforated core where it exits the filter. If the dirty fluid passes through the inner layer of pleats, the dirt is removed and the clean fluid enters the perforated core directly.

Note: Fluid will always take the path of least resistance. This principal forces the filter to load evenly with dirt. As one area of pleats become loaded, the differential pressure across that area becomes higher. Then, the fluid will seek a pleated area with a lower differential pressure across the media.

The cost benefits of increasing the effective filter surface area available within a filter housing becomes obvious when we look at its affect on increased filter life. Filter life is related to a filter's dirt holding capacity and can be defined as the total volume of fluid that passes through a filter before it reaches its maximum operating differential pressure. Under a constant flow rate, the life of most absolute rated filters is greatly increased when their effective surface areas are increased. This property of filter life is a direct relationship between flow density (gallons per minute per square foot of filter media) and the resulting differential pressure across the filter area. The only limitation to this concept is that the filter element construction must contain enough void space to hold the additional filter cake that is generated.

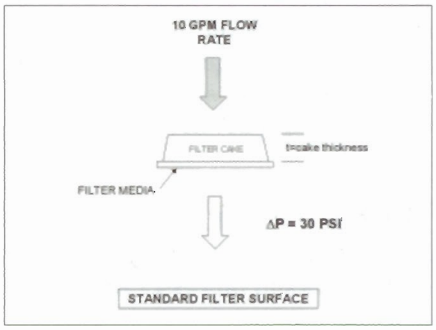
$$\text{Filter Life Increase} = \left(\frac{Le}{Lo}\right) = \left(\frac{Ae}{A}\right)^N$$

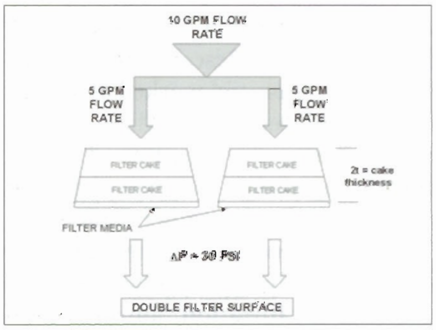
Where: Le = Extended Filter Life
Lo = Original Filter Life
Ae = Expanded Filter Area
Ao = Original Filter Area

$1 \le N \le 2$

Upon analysis of the formula, one finds that doubling the effective filter surface area can increase filter life up to four times.

An example of how this works is shown graphically below:





EXAMPLES OF THESE COST SAVINGS

Chemical Plant ABC using 20 micron absolute (polypropylene media) standard pleated cartridges:

1. 15" ID filter vessel holds nineteen 2.5" OD cartridges
2. Each filter costs $40.00
3. Each filter (50 pleats) has an effective surface area of 13.9 sq. feet, for a total of 264.1 sq. feet
4. Direct cost of change out is $760.00

Converting to 12.75" OD Filter

1. 15" ID filter vessel holds one 12.75" OD cartridge
2. Each filter costs $1,044.00
3. Each filter has an effective surface area of 390.1 sq. feet (Equivalent to twenty-eight of the 2.5" OD filters)
4. Direct cost of change out is $1,044.00

However, filter life between change outs has increased by the following:

Filter Life Increase =

$$\left(\frac{Le}{Lo}\right) = \left(\frac{Ae}{Ao}\right)^N$$

Where: Le = Extended Filter Life
Lo = 1
Ae = (1 x 390.1) = 390.1 sq ft
Ao = (19 x 13.9) = 264.1 sq ft

$1 \le N \le 2$

Surface area increase = 1.48

Filter life increase, depending on the value of N, is between 1.48 and 2.19 times original life. Averaging the two values gives us a new estimated life of 1.84 times the life of the 2.5" OD filters. Therefore, the average normalized change out cost for the 12.75" OD filter is $ 567.39. This represents an average cost reduction of 25.3% in direct costs.

Chemical Plant XYZ using 20 micron absolute (polypropylene media) standard pleated cartridges:

1. 22" ID filter vessel holds forty 2.5" OD cartridges
2. Each filter costs $40.00
3. Each filter (50 pleats) has an effective surface area of 13.9 square feet, for a total of 556 sq feet.
4. Direct cost of change out is $1,600.00

Converting to 20.0" OD Filter

1. 22" ID filter vessel holds one 20.0" OD cartridge
2. Each filter costs $3,065.25
3. Each filter has an effective surface area of 1161.1 square feet (Equivalent to 83 2.5" OD filters)
4. Direct cost of change out is $3,065.25

However, filter life between change outs has increased by the following:

Filter Life Increase=

$$\left(\frac{Le}{Lo}\right) = \left(\frac{Ae}{Ao}\right)^N$$

Where: Le = Extended Filter Life
Lo = 1
Ae = (1 x 1150) = 1150 sq ft
Ao = (40 x 13.9) = 556 sq ft

Surface area increase = 2.09

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A gas processing plant in Wyoming using this new cartridge filter technology.

Filter life increase, depending on the value of N, is between 2.09 and 4.37 times original life.

Averaging the two values gives a new estimated life of 3.238 times the life of the 2.5" OD filters.

Therefore, the average normalized change out cost for the 20.0" filter is $949.00.

This represents an average cost reduction of 40.7% in direct costs.

The savings associated with filter housing costs is equally important. Many plant engineers design their filtration systems based on a maximum flow rate per square foot of filter media. If a 2.5" OD filter is used in the base flow rate calculations, a larger vessel will be required to meet the maximum flow requirements. Using the large diameter cartridge designs will minimize the filter vessel size required for specific flow rates. This factor can result in significant cost reductions when high-pressure filter vessels are a necessity.

This new filter cartridge technology provides an excellent opportunity to reduce existing and future filtration costs by reducing overall filter cartridge direct costs, minimizing capital expenditure for filter housings, lowering cartridge disposal costs, reducing labor costs of cartridge change out, and increasing run times.


30-inch pipeline in the Gulf of Mexico with 20.0 OD filter

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