Filter Cartridges or Filter Bags?

Six ways filter bags compare to filter cartridges

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Filter Cartridges or Filter Bags?
Disposable filter media in cartridge and bag forms retain particulate within a 0.03 to 200 micron range. Which aspects of your application favor one design over the other?

What is a disposable cartridge filter?

They are a cylindrically shaped porous media typically 10, 20, 30 or 40 inches in length and having an outside diameter of 2½" to 2¾". The supporting substrate or inner core typically has a 1" ID and the ends of the cartridges are available in several configurations to match the design of the filter vessel. The filter vessel fills with the process fluid, and to exit the vessel, it must pass through the outer layers of the cartridge, into the hollow inner core and a through common drain manifold.

Four Common types of disposable filter cartridges

1. String wound cartridges are very inexpensive and common for less demanding applications. As the name implies "strings" of porous material are wrapped around a central core and since there is no defined pore structure, they do not provide absolute efficiencies and thus relegated to less demanding applications such as pre-filtering water to extend the life of more costly (advanced) filter cartridges downstream.
2. Melt blown filter cartridges consist of dual layers of media density to free-up the inner layer for finer particle retention. The density, described as "multilayered", is actually a single piece design due to the melt blown manufacturing process used to create them.
3. Membrane filter cartridges employ a fixed pore structure with a uniform density, typically used for fine particle retention and designed for a long service life.
4. Pleated style filter cartridges provide depth filtration with a fixed pore structure with increased surface area due to their pleated design.

If the particle concentration exceeds 100 PPM or 0.01% of the weight flow, a filter cake can form and thus would be a candidate for a non-disposable, back-washable filter cartridge.

What is a disposable filter bag?
Filter bags, sometimes referred to as filter "socks" because they have a single opening through which the particles enter and become trapped, allowing only filtered fluid to enter the filter vessel and discharge through the outlet. The thickness of the filter bag material, its material, number of layers it has, its geometry (which can include pleating) and the method of sealing the filter bag to the vessel all contribute to its efficiency.

Many of the same considerations for selecting filter cartridges apply to filter bag selection:

a) Fluid compatibility
b) Flow rate
c) Temperature
d) Retained particle characteristics such as size range and whether they are deformable

Absolute vs. nominal ratings
An absolute rating means that the efficiency for retaining a given particle size is per a specific Beta Ratio established via laboratory testing with engineered particles of known sizes and quantities. Nominal ratings apply to media structure that is not capable of such repeatability in laboratory tests. The majority of industrial applications for both filter bags and filter cartridges are satisfied with nominally rated designs typically having initial retention efficiencies of 65%+ and relying on formation of filter cake to gradually increase efficiency. Some of the less expensive filter cartridge and filter bag housing designs cannot provide an absolute level of element sealing and thus using nominally rated filter media makes sense.

When the application requires very definitive particle retention efficiency from the start, absolute rated media is required and, it is important to add, the vessel design needs to seal against the media with the same efficiency.

Sizing considerations
Select filter bag and cartridge systems to ensure the initial clean differential pressure is ≤ 5 PSI because once the differential pressure reaches as high as 35 PSI there is a likelihood of rupture. The idea is to maximize the full retention potential between 5 and 20 PSI of differential pressure, allowing time to initiate changing of the filter media. Assuming a continuous flow rate and particulate load, clogging and increase of differential pressure is exponential, so although the maximum allowable differential pressure might be over 30 PSI, you would not try to time it that close for most applications.

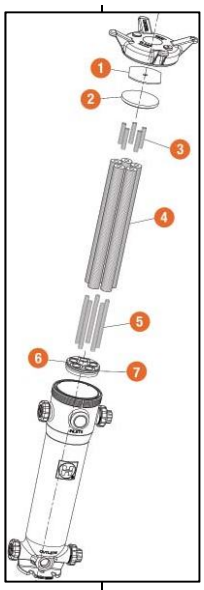
Six ways filter bags provide a cost effective and flexible solution compared to filter cartridges:

1. Viscous Fluids
Viscosities >50cP tend to favor filter bags due to their larger surface area which would otherwise require many more cartridges. The number of filter cartridges required for high flow rate applications becomes impractical.

2. Reduced cross contamination
When a filter bag is removed from the vessel the likelihood of particles bypassing the filter media is reduced because there are only two sealing points, between the restrainer (support) basket/housing and between the bag/restrainer basket. The retained particles

"fall" into the filter bag, so when it is removed all the particles are removed with it.

Conversely, the flow path for filter cartridges is from the outside to the inside. Removing cartridges from the vessel exposes the discharge port to the filter vessel area that was in contact to the unfiltered fluid and increases chance of particle bypass. Often multiple cartridges are required per vessel thus the number of sealing points can be significantly more when compared to a bag filter system. A thorough cleaning of the vessel prior to installing the replacement cartridges reduces potential for such cross contamination, but such additional labor & time should be factored into the overall "ongoing cost" of the filter system.



3. **Cost of Ownership**
   The cost of replacing the filter media is one aspect; others include frequency of replacement and waste disposal cost. The frequency of replacement addresses not only the annual units of media to be purchased but also the number of interactions personnel have accessing the vessel and exposing themselves to the fluid, so it involves labor and safety "costs".

   Although it depends upon the specific filter bag, filter cartridges typically cost at least twice as much as filter bags for a given flow rate especially because multiple cartridges are required per filter bag for a given flow rate.
4. **Disposal costs**
   While filter cartridges have less potential for retained fluid, the volume of cartridges to dispose of can be substantially more when compared to fewer filter bags. Using a #2 size bag filter vessel as an example for a 100 GPM application, it would require (5) 30" long cartridges, thus five times the number of cartridges are disposed of compared to just 1 filter bag and this directly effects your waste disposal costs. In addition, when disposal involves incineration you will discover that filter bags dry out better than a saturated and dense filter cartridge.

5. **Reduction of labor cost is a big consideration**
   Since the sealing of cartridge filter assemblies is more complex (requiring washers, nuts and sealing plates) replacing them can be a tedious procedure; here is an example of a typical scenario that takes about 10 minutes to service:
   a) Assuming a 30 GPM filtration system using (6) stacked 10" filter cartridges, the replacement procedure involves removing the chamber cover, retaining nuts/washers and cartridges.
   b) Washed the vessel and that fluid is sent to drain or reclaimed for disposal.
   c) Install new cartridges

When compared to a single filter bag system, the vessel-cleaning step is not necessary and thus there is less fluid "disposed". There are also no nuts/washers involved – no tools are required at all to swap-out a filter bag and therefore typically the time spent for each change-out is ½ what the cartridge system requires.

If you "invest" in more expensive, high particle loading filter bag designs, the frequency of change-outs would be less, maximizing the reduction in labor.

5 minutes – doesn't seem like a big deal, but if that is multiple times per day and there are multiple housings that adds up to a lot of "minutes" for a typical 260 day work schedule. Saving just 10 minutes a day equates to a reduction in labor of over 40 hours per year.

Another benefit of reduced labor is less exposure to the process fluid, which involves personnel safety and product quality assurance.

6. **Flexibility**
   Bag filter vessels have the space to insert magnetic assemblies to remove magnetic material and reduce the clogging rate of the filter bag. We use powerful 9300 gauss magnets encased in 316SS and placed into a holder that sits in the filter bag.

A case for filter cartridges

Filter cartridges are best suited for lower flow rates, water-like fluid viscosities and finer retention applications. This reduces the number of cartridges required, making them an affordable alternative.

Hazardous and valuable fluids benefit from the compact size of filter cartridges, which have less potential for retaining fluid. Although using a displacement balloon with a filter bag system reduces retained fluid, if the flow rates are relatively low, a cartridge system probably makes sense.

While 500F is the maximum for PTFE felt filter bags, porous titanium and 316SS filter cartridges are suitable for temperatures up to 700F.

The importance of involving a filtration specialist cannot be overstated; we have years of experience working on applications, if not identical to yours, most likely with something similar and we learn from both our mistakes and those that our customers have made. We solve problems and use our insight to contribute to a well thought-out suggestion. We also have access to free product samples and rental filter vessels for testing.

Chris Pasquali has been trained by Hayward Flow Control and Eaton Filtration, having provided sales and engineering support since 2001.