How Liquid Viscosity Affects Filter Bag and Filter Cartridge Applications

By: Chris Pasquali, CEO Factory Direct Pipeline Products, Inc.

Filtration is an essential process across various industries, serving to purify liquids and remove contaminants for downstream applications. Choosing the right filtration method, whether using filter bags or filter cartridges, is critical to achieving optimal performance. One of the key factors influencing this decision is the viscosity of the liquid being filtered, especially if it differs significantly from water. Viscosity is a measure of a liquid's resistance to flow and thus impacts the filtration process, including liquid velocity and differential pressure. This article explains the relationship between liquid viscosity and filtration, the advantages of filter bags or filter cartridges in different scenarios, and some examples of common high and low viscosity liquids filtered with filter bags and filter cartridges.

Understanding the Impact of Liquid Viscosity on Filtration

Viscosity plays a fundamental role in liquid filtration as it affects how the liquid flows through the filter media. Liquids with higher viscosity have thicker and slower flows at a given pressure, while low-viscosity liquids exhibit thinner and faster flows at that same pressure. This difference in viscosity significantly influences liquid velocity and differential pressure across the filter media.

Examples of High Viscosity Liquids:

- Heavy oils and lubricants
- Molasses
- Polymer solutions
- Resins and adhesives

Examples of Low Viscosity Liquids:

- Water and aqueous solutions
- Light oils and fuels
- Solvents
- Beverages and juices

Liquid Velocity

In the context of liquid filtration, liquid velocity refers to the speed at which the liquid flows through the filter media. High-viscosity liquids experience reduced flow velocities due to their inherent resistance. As these liquids traverse the filter media, they must overcome the small pores and interstitial spaces, resulting in slower movement and lower liquid velocities.

This is problematic for both filter bag and filter cartridge filtration because it can contribute to uneven flow distribution across the media. It can be off-set somewhat by operating at a higher pressure and thus filter cartridges might be a better choice due to their inherent ability to handle higher differential pressures.

There are filter bag designs, such as Eaton's MAX-LOAD, which have comparable differential pressure ratings but also offer the advantage of higher flow rate capacities and increased surface area in support of less frequent media replacement and an overall simpler housing design.

Bag filter housings are designed to accommodate accessories which filter cartridge housings are not, namely liquid displacement balloons and magnetic inserts. The displacement balloons would help even-out the liquid distribution and for applications where magnetic inserts are desired, the increased residence time amplifies their effectiveness.

Differential Pressure

Differential pressure is the pressure difference between the inlet and outlet sides of the filter. High-viscosity liquids tend to generate higher differential pressures for a given flow rate due to their increased resistance while passing through the filter media. If the liquid is conveyed with a positive displacement pump system, the flow rate will remain constant as the differential pressure increases and the velocity through the filter media will increase as the open area is reduced. Centrifugal pump and other fluid delivery systems may deliver less flow with an increase in differential pressure, reducing the liquid velocity and perhaps effecting the downstream process with the reduced flow rate.

Filter Cartridges: Ideal for High Viscosity Liquids

The high viscosity applications in which filter cartridges are commonly used have a couple of characteristics besides higher differential pressure tolerance that favor filter cartridge designs: lower flow rates and necessity to retain finer solids.

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Single filter cartridge systems are limited in flow rate to approximately 1 GPM per inch of length and the longest filter cartridges offered through Eaton are 40" long. If the flow rate is significantly higher than 40 GPM, it might be more cost effective to use a single filter bag housing design compared to a multiple filter cartridge design in terms of initial cost and ongoing cost related to media replacement.

Filter bag designs that have similar maximum differential pressure capabilities as filter cartridges are limited in their filtration efficiency and size of particles which can be retained. Filter cartridges tend to be more efficient and there are many designs for submicron levels of filtration.

Therefore, if the flow rates are on the higher end and a nominal >1 micron particle retention is required, filter bags might be the most cost-effective solution whereas filter cartridges provide more options for higher efficiency retention of finer particle sizes and are especially cost effective for <40 GPM flow rate applications.

Eaton Filter Cartridges			Eaton Filter Bags		
2.5 in. Diameter			7 in. Diameter (4 in Diameter for the 9 and 15 in lengths)		
Length (in)	SQFT Surface Area	Max Flow Rate (GPM)	Length (in)	SQFT Surface Area	Max Flow Rate (GPM)
10	0.5	11	9	0.9	26
20	1.1	22	15	1.7	53
30	1.6	33	17	2.6	88
40	2.2	44	32	5.2	176

Advantages of Filter Bags in Versatile Applications

While filter cartridges are advantageous in specific scenarios, filter bags have advantages as well.

Larger Surface Area

Filter bags generally have a larger surface area compared to individual filter cartridges. This attribute makes them highly effective for filtering low to moderate viscosity liquids. Thus, for the higher flow rate applications where sufficient liquid velocity is available, the increased surface area increases the duration between media replacement. This also contributes to maintaining a lower differential pressure and perhaps a more consistent flow rate.

Cost-Effectiveness:

Filter bags are typically less costly for high flow rate applications because filter cartridge systems often require multiple cartridges to handle higher flow rates which can be accommodated by a single filter bag. This is especially true for applications which require nominal filtration efficiency of particles >1 micron as the cost for complex filter bags with absolute rated efficiency are quite expensive and more susceptible to damage via higher differential pressures.

Specialized Accessories

Filter bag systems offer various accessories, such as displacement balloons and magnetic inserts, which can enhance filtration performance in specific applications. Displacement balloons reduce the liquid retained within the filter bag and inadvertently help maintain a higher velocity across the filter bag surface; they reduce loss of process liquid due to media change-outs. Filter cartridge systems generally retain less unfiltered liquid, so the addition of displacement balloons to bag filter systems enable you to benefit from the other aspects of filter bags while reducing loss of process liquid.

Magnetic separators are very powerful magnetic assemblies that reside within the center of filter bags and they significantly increase the retention efficiency of ferrous particles. Magnetic separators will extend the duration between media changes for any liquids that contain high levels of ferrous particles and benefit any application for which such metal fines are problematic. There is no equivalent magnetic separation for industrial filter cartridges.

Complexity and Cost Considerations

Higher flow rate applications can be accommodated with a smaller filter vessel size and use fewer filter units when using a filter bag housing. The inherent higher capacity of filter bags (up to 4x the flow rate of the largest filter cartridge offered by Eaton) results in less sealing points within the vessel; the simplification of design lowers the cost of the vessel, and contributes to less downtime for replacing clogged media.

Multiple Bag Filter Housing

Multiple Cartridge Filter Housing

Filter bags are often more cost effective than filter cartridges, although there are less options for applications having higher differential pressures or applications which require high efficiency submicron particle retention.

Conclusion

In conclusion, selecting the right filter bag or filter cartridge style depends on the viscosity of the liquid and the specific requirements of the filtration process. Filter cartridges excel in handling higher viscosity liquids with elevated differential pressures and finer solids, making them suitable for specific applications. Certain models are designed to withstand higher liquid temperatures and others are designed to mitigate fiber migration of the filter media itself. On the other hand, filter bags offer larger surface areas and cost-effectiveness, making them a versatile choice for most applications involving low to moderate viscosity liquids. Understanding the impact of liquid viscosity on filtration helps make informed decisions, ensuring optimal filtration performance in diverse industrial settings. Whether it's filter bags or filter cartridges, choosing the right filtration method is crucial to achieving efficient and effective liquid purification.

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