Delta Pure
Reliable Filtration

Basics of Filtration

Cartridge Filtration Driving Forces

Filtration
The removal of a suspended particle from a fluid, liquid or gas, by passing the fluid through a porous or semi permeable medium.

Separation
The removal of a dissolved substance (solute) from a carrier fluid stream (solvent). Cartridge filtration is typically pressure driven. Other types of filtration and separation devices may employ alternative driving forces: gravitational settling, centrifugal force, a vacuum, etc. There are several advantages associated with using pressure as the driving force in a cartridge filtration system:

- Greater output per unit area
- Smaller equipment than when using other driving forces (consider settling ponds and deep bed filters)
- Ease of handing volatile liquids.

Pressure Drop
There must be a difference in pressure between the inlet and outlet sides of a filter in order to push a liquid through the filter. This pressure differential is largely influenced by the resistance to flow of the filter or medium. The pressure differential is the difference in pounds per square inch (PSI) of KPa between the inlet and outlet ports. Pressure differential may be referred to as PSID, ΔP, pressure drop, or differential pressure.

System Pressure Drop
The actual system pressure drop (difference in pressure between the inlet and the outlet) is due to loss of PSI, resulting from loss of flow through the cartridge and loss of flow through the housing. Both losses contribute to total ΔP.

Cartridge ΔP increases throughout the filtration process as the cartridge collects dirt and becomes more resistant to flow. Housing ΔP remains constant (assuming constant flow rate and fluid density).
Total System Pressure Drop
$\Delta P = \Delta P$ Cartridge + ΔP Housing

Cartridge Pressure Drop
Fluid flows through channels created by pores in the filter medium. This is called laminar flow, moving in orderly layers, rather than in a turbulent manner. During laminar flow, pressure loss resulting from flow through the cartridge is dependent upon.

1. Micron Rating
2. Viscosity (centistokes-cSt)
3. Flow Rate (gallons per minute, GPM)

Change in pressure drop can be calculated with the following equation: $\Delta P = AuQ$

Where:
ΔP = Pressure Drop
A = Cartridge (laminar) flow constant
U = Viscosity (cps)
Q = Flow rate (gpm)

Housing Pressure Drop
All flow in housing must pass through the same inlet and outlet port restrictions, which represent only a few square inches in area. Flow through the cartridge filters may be divided among several square feet of area.

Thus, the flow rate per unit area through filter housing ports is typically higher than the flow rate per unit area through cartridge media. This high flow rate produces turbulent flow in the housing as fluid disperses through the inlet port or seat cups and into the less restrictive housing cavities. Housing pressure drop increases as flow rate and/or fluid density increase but decrease as port size and the number of seat cups increase (seat cups/plates hold column of cartridges).
Housing pressure drop is affected by four main variables:

1. Flow Rate
2. Fluid density, expressed as specific gravity
3. Inlet and outlet port sizes
4. Number of seat cups (seat plate) in the separator plate

Open, Parallel and Series Filtration Systems
Filtration systems can be arranged in a number of different configurations or plumbing arrangements. These configurations affect the P of the system. One possible variation is to have an open system, or a system, or a system in which the clean effluent is dumped into a tank open to atmospheric pressure. Under these conditions, the total P is equal to the influent pressure, since all system pressure is lost on the downstream side. Another possible plumbing arrangement is to have two or more systems (housings + cartridges) set up in parallel. In this scenario, the total flow rate will be the sum of the flows of each system. The total P will be the same as the P for each component of the overall setup.

Another configuration is a series filtration system. In this case, coarser pre-filters are plumbed in before tighter final filters, producing an accumulative reduction in contaminant levels.