System Sizing

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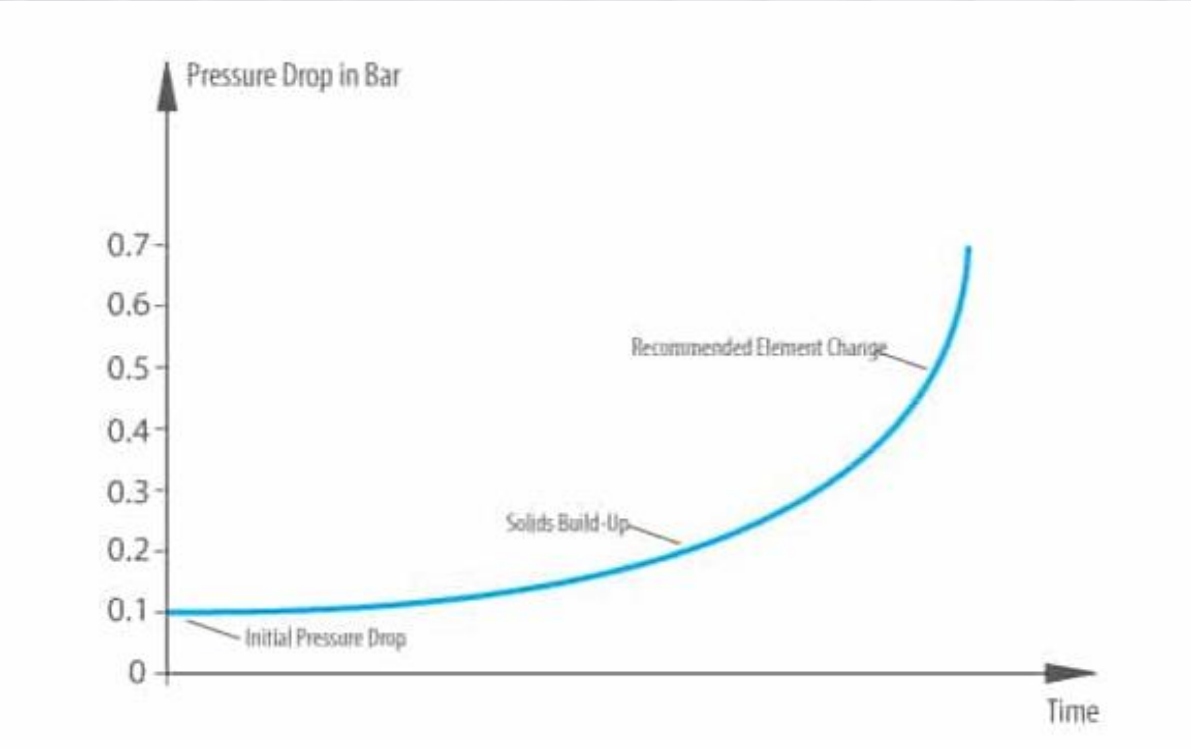
Marmon Water, Inc.

Technical Topics



System Sizing

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System Sizing

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What factors must be considered?

A well-designed system must remove contaminants according to a predetermined specification while maintaining an acceptable life, process ease and cost.

Factors Influencing Design

- Process fluid chemistry
- Flow rate
- Temperature
- Viscosity of fluid
- Dirt Load
- Clean Pressure Drop desired
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- Desired level of filtration
  - Micron rating
  - Nominal or absolute
- Batch or continuous process
  - If batch – volume and time

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Specifying the Application

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Housing

- Choose compatible materials of construction
- Carbon steel, 316 SS, 304 SS
- Industrial or sanitary type
- Code or non-Code
- Other design specs such as CE, PED, etc
- Surface finish
- Painted, bead blast, electropolished
- Pressure rating desired

Cartridge

- Material of Construction for chemical compatibility
- Depth, pleated, membrane, High Flow
- End style
- NN style depth for lowest cost
- 226 style membrane for ultimate in seal assurance

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Multi-step Process

- Minimum Core Requirements
- Flow Rate per TIE (ten-inch equivalent)
- Pressure Drop & Viscosity Considerations
- Actual Test Data

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Minimum Core Requirement

Calculate as system flow rate/15

- ✓ Example: 100 GPM Flow rate

100/15 = 6.6 or 7 cores at minimum

This calculation tends to oversimplify and could result in too high flow rate for the media but use as a minimum size to quickly baseline minimum size.

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Flow Rate per TIE (ten-inch equivalent)

Recommended Flow per TIE:

- Membrane: < 3 GPM
- Pleated Media: < 5 GPM
- Depth Media: < 5 GPM

✓ Example: 100 GPM flow rate system

- Membrane – 100/3 = 33 TIEs
- Pleated or depth – 100/5 = 20 TIEs

This calculation does not include the effects of viscosity or clean pressure drop targets

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Pressure Drop & Viscosity Considerations

Use the actual filter delta P data from the literature in the calculation

Minimum Cartridge Quantity =

$$\frac{\text{System Flow Rate}}{\text{Filter Flow (@1psid) x Desired Clean } \Delta P} \times \text{Fluid Viscosity}$$

✓ Example: 100 GPM $\frac{100}{3 \text{ GPM x 1 psid}}$ x 1cps = 33 TIEs

Note the influence of viscosity and desired clean delta P on number of filters needed

- If viscosity is 3 cps, then 3 times as many TIEs needed
- If customer can live with 3 psid clean delta P then need 1/3rd as many

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Actual Test Data

Based on actual testing of the filter with the customer's fluid

Usually done with a 10" filter/housing

- ✓ Example: Customer wants to process a 10,000 gallon batch at 100 GPM and using 0.2 micron ZTEC
  - Run 10" sample at 3 GPM flow
  - Record volume throughput until filter is at 80% of usable life
  - Data shows 335 gallons of throughput per TIE
  - To process 10,000 gallons will require 10,000/335 = 30 TIEs

This is the best way to determine actual on-stream life, but may not take into account the target flow, viscosity or pressure drop

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Summary

- Step 1 – Minimum Cores
  - 7 cores
- Step 2 – Flow rate per 10”
  - 33 TIEs
- Step 3 – Using Filter flow/delta P data
  - 33 TIEs(@1 psid clean delta P)
- 11 TIEs(@3 psid clean delta P)
  - Step 4 – Based on actual filter test
- 30 TIEs

Final recommendation would be 12 x 30” (nearest that is commercially available), driven by the flow requirement

System Sizing: Air

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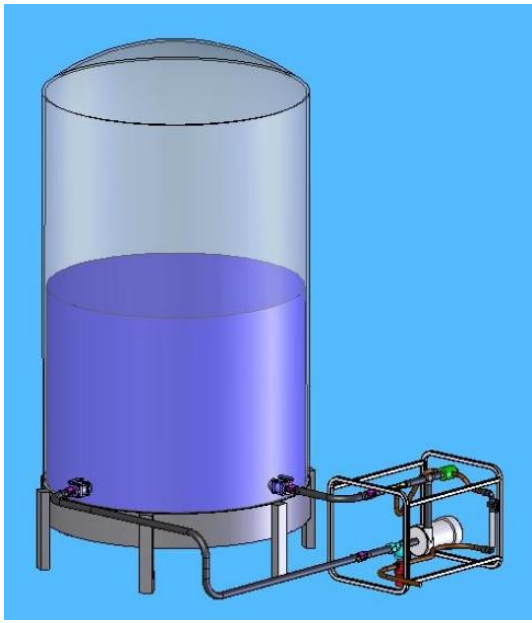
What factors must be considered?

To maintain proper air flow in the tank, system sizing is a very critical process. Failure to properly size a tank vent may result in catastrophic collapse of the tank.

Application Brief AB-002 covers this topic

Factors influencing design:

- Tank volume
- Tank vacuum rating
- Fill or discharge rate of the system
- Temperature
- Steam
- Operation



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System Sizing: Air

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Sizing a vent filter housing

- Identify the air flow rate into and out of the tank
  - Determined by using the liquid flow rate (gpm) with the conversion factor of 7.48 gal. = 1 cfm.
  - Calculate on the largest value of fill or discharge
- Identify the operating temperature of the system
  - Critical if steaming is being conducted.
- Identify the maximum vacuum allowed in the tank (in psid).

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Additional Guidelines

The recommendation will typically include a safety factor of 2X - 3X to in order to minimize risk to equipment.

The crush strength may not be the limiting factor as a rupture disk (recommended) or a vacuum gauge with an electrical cutoff could reduce the working vacuum available.

Design should not be at the filter (flow) or tank limits

System Sizing: Air

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Additional Considerations

Vent filters tend to have significant life spans - 3 months to 1 year. The life will depend upon a number of factors including environmental conditions, the operating temperature of the system.

High temperatures will have a negative impact on filter life.

- Steam cycles are common to prevent microbial contamination - will cause expansion and contraction of the filter (as it cools) which may ultimately damage the structural integrity of the filter.
- Use of a steam jacketed filter housings or heat tracing on the filter housing, the constant high temperature, which may range from 65° C to 120° C, results in oxidation of polypropylene components and may lead to failure.

System Sizing: Air

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Additional Considerations

To function properly, the media must remain dry - wetted filter is impermeable to the bulk flow of air until the pressure reaches a point where the liquid in the pores is displaced (bubble point!).

- Avoid contact with either the contents in the tank or environmental conditions. Since tank venting is done at essentially atmospheric pressure, this pressure is not achieved and may be higher than the vacuum or pressure rating on the tank
- It is best practice to choose a hydrophobic material for the application, with PTFE membrane being the optimal choice.

Because of the critical nature of vent filter sizing, Graver recommends you consult with us to assist in this exercise, particularly when steam is used to sterilize.

“Any sufficiently advanced technology is indistinguishable from magic”

Arthur C. Clarke

Questions