3M Purification Inc. (formerly CUNO)

Final Filtration

with microporous membrane filter cartridges

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Do Filters Harm Wine?

- They can - but only if used ***carelessly***, just like any other operation in the winery.
- Benefits far outweigh potential problems
  - understand how and when to use given filters
  - proper operation minimizes any negative effects
- General agreement that desirable wine components are significantly smaller than the 0.45 micron pore size.
  - Refer to work of Dr. Christian Butzke - President ASEV

When to Filter

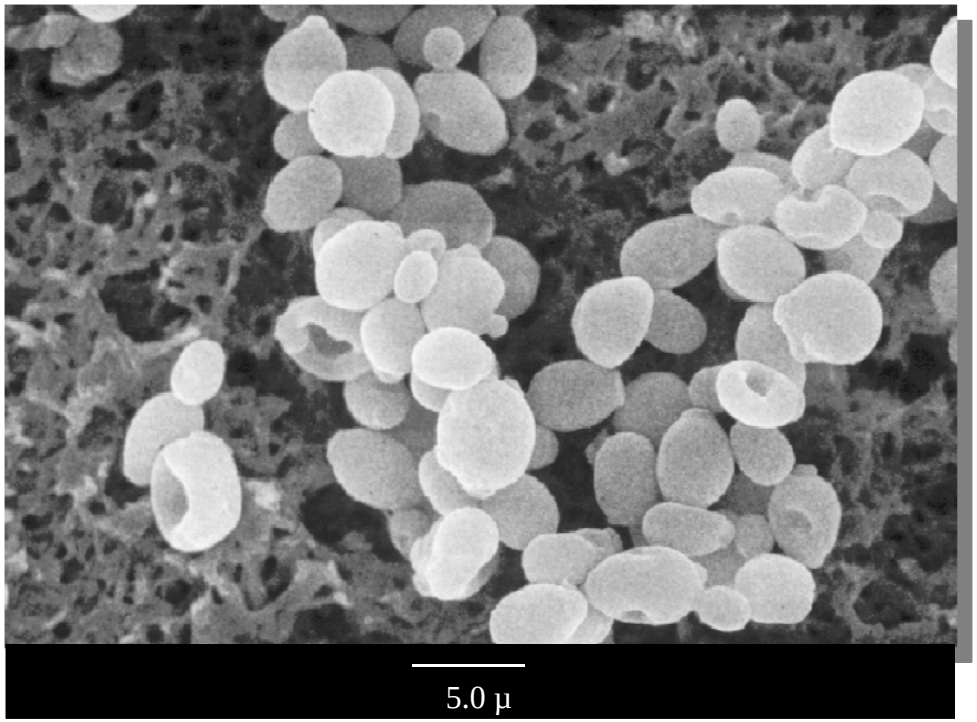
- RS of 2 g/L and above
  - enough “food” for microorganisms to grow on
  - wines with >40 CFU/ml yeast
- ML (malolactic) incomplete, or blended wines
  - refermentation possible
  - wines with > 200 CFU/ml malolactic bacteria
- Turbidity of >1 NTU
  - can be indication of microbial activity
- Instance of Brett (or bacterial) infections

Before Membrane Filtration

- Wine must be free of turbidity: NTUs <1
  - Careful racking
  - Fining agents
  - Primary filtration (“pink” DE, cross flow)
  - “sterile” grade sheet/depth cartridge filtration
- If using a depth filter step, conduct final membrane filtration within 24 hours
- Have proper equipment/supplies on hand
  - Clean filtered water (ambient, warm ~55ºC, and hot ~ 80ºC)
  - Integrity test equipment, including nitrogen/compressed air
  - Storage solution
  - Pump, valves, gauges, fittings

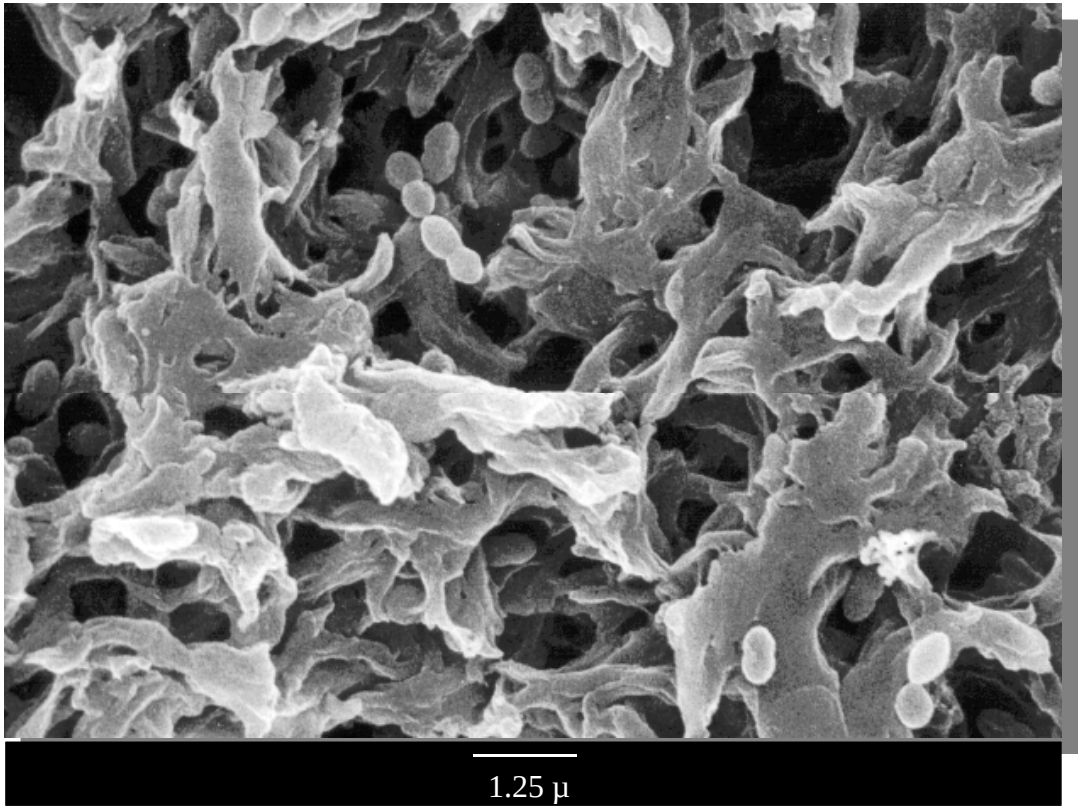
Yeast Cells

SEM photograph of *Saccharomyces cerevisiae* on Nylon 0.45 µm LifeASSURE™ Membrane

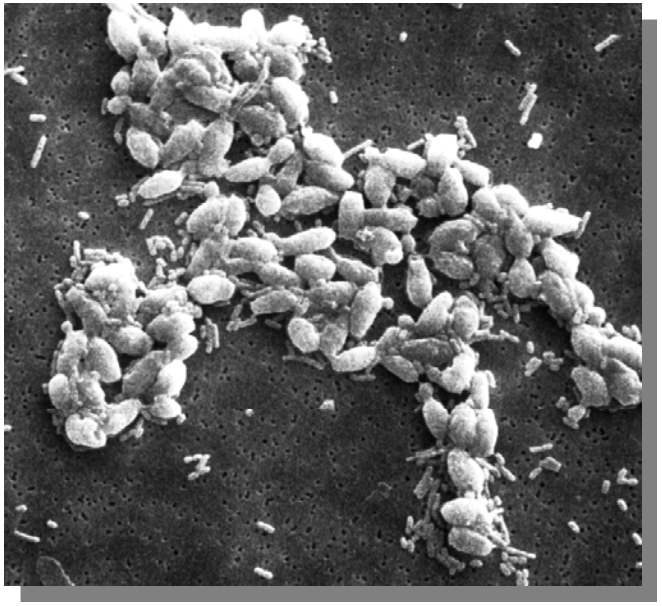


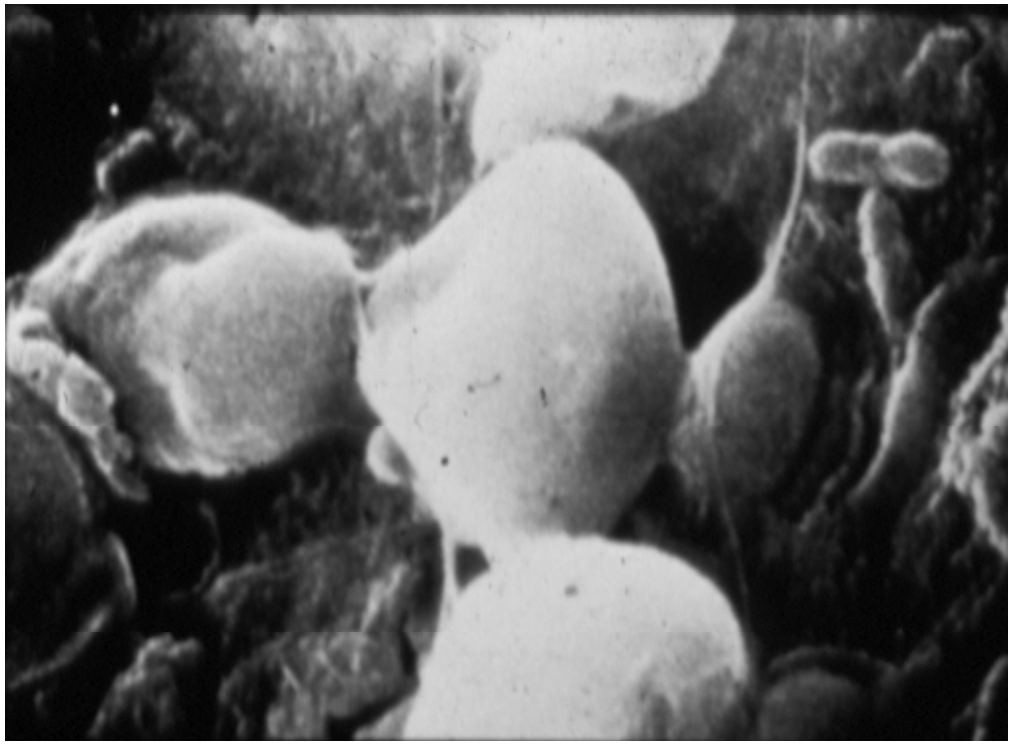
Malo-Lactic Bacteria

Oenococcus oeni (formerly *Leuconostoc oenus)* on a 0.45 Micron LifeASSURE Membrane



Yeast And Malo-Lactic Bacteria





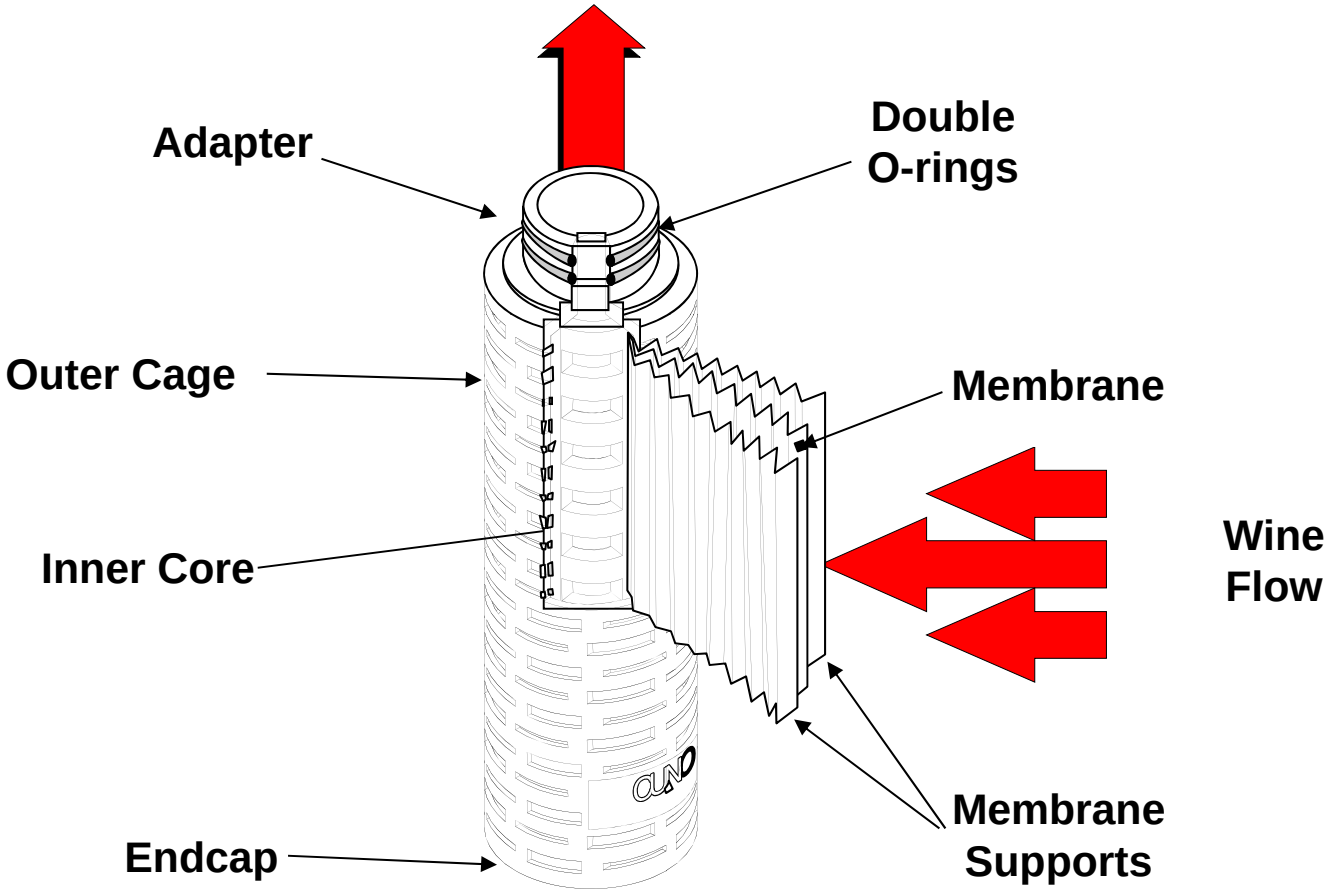
Microorganisms in Wine

Microorganism	Critical Dimension
Lactobacillus sp.	
L. brevis	0.7 µm
L. casei	1.5 µm
L. plantarum	0.9 µm
Pediococcus sp.	
P. damnosus	0.6 µm
P. parvulus	0.8 µm
P. pentosaceus	0.8 µm
Leuconostoc oenos	0.5 µm
Saccharomyces sp.	3 µm
Brettanomyces sp.	3 µm

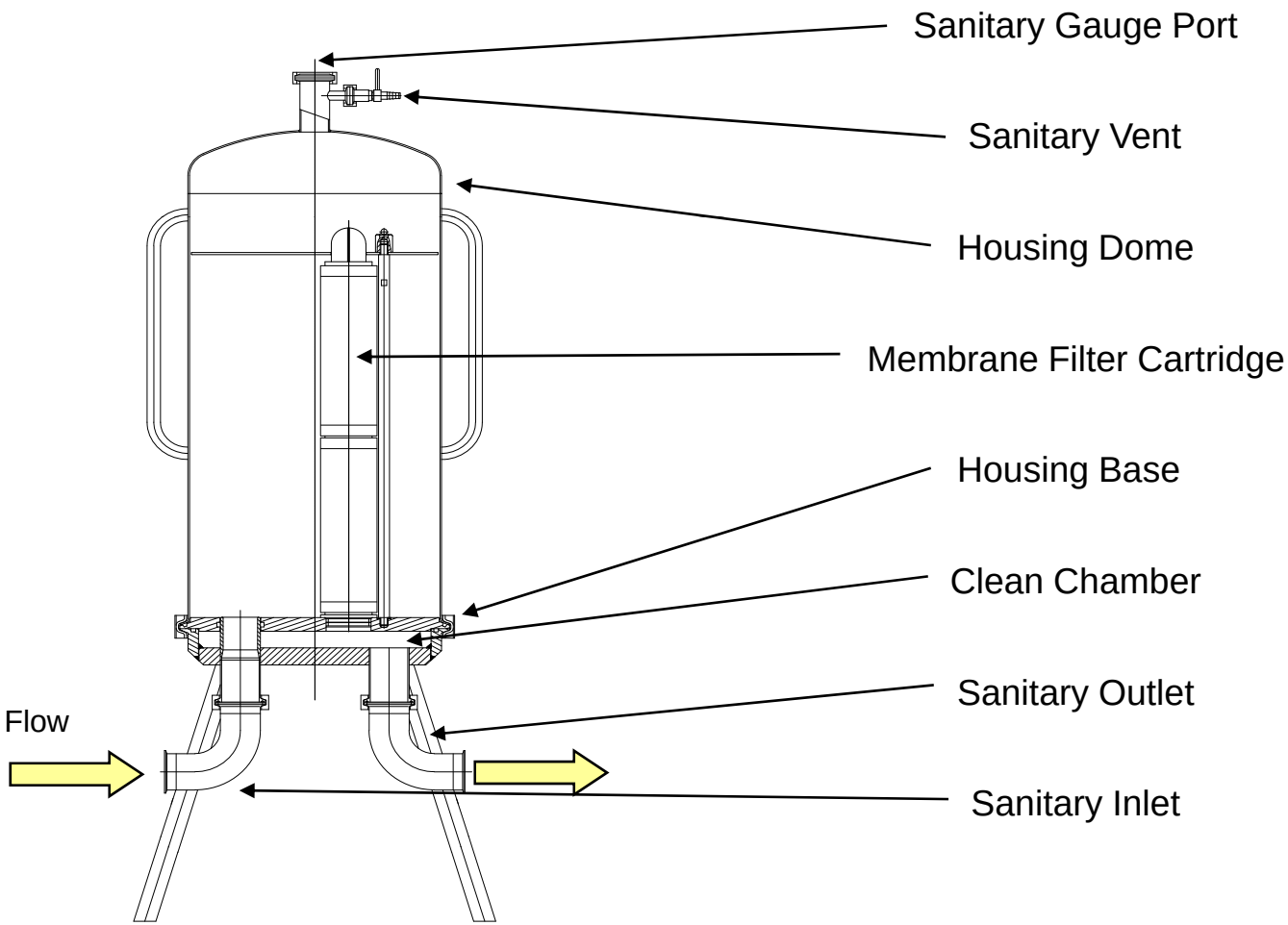
Final Membrane Filters

- Long history of use in wineries
- Thin, micro-porous membranes made from non-reactive polymers
- Pleated (to increase surface area)
- Contained in disposable filter cartridges
- Remove microorganism through size exclusion
- Require prefiltration of wine for best economics

Membrane Filter Cartridge Construction



Membrane Filter Vessel



3ZWB3 Model: three 30” filters

Important Membrane Filter Attributes

- Retentive Ability
  - Should be demonstrated with wine specific organisms (*Oenococcus*, Brett) and not pharmaceutical organisms
  - 0.45 µm and 0.65 µm most common ratings
- Integrity Testable
  - Ensures that the filter is operational and retentive
- Durability
  - Repeated hot water
  - Sanitation chemicals (if used)
- High Throughput
  - Consider the entire filter chain
  - Maximize each unit operation for overall best performance

"Sizing" a Filter System

- what size/how many filters do I need?

1. Choose your desired flow rate
   - Typically this will be the flow rate to the filling machine
2. Determine what you want for a "clean" or initial pressure drop
   1. Commonly between 1 and 5 psid
3. Select your desired filter and micron rating
4. Review the flow vs pressure drop data
5. At your desired initial pressure drop, determine the flow per 10" filter
6. Divide you desired flow rate by the flow per 10" filter to determine how many 10" equivalents are needed at your flow rate.
   - A single 10" or 30" filter are most common for smaller wineries
   - 3 x 30", 12 x 30" assemblies are most common for larger wineries

"Sizing" a Filter System

- what size/how many filters do I need?

- Filling machine flows at 6 GPM
- Want to start at a clean pressure drop of 1 psid
- From the data in the membrane filter literature, you determine that a 10" filter deliver a flow rate of 2 GPM at a 1 psid pressure drop.

- 6 GPM (desired flow rate) = three 10" filters, or one 30" filter

  2 GPM/10" filter

Membrane Filter Preservation

- can I save the filter after filtration to reuse?

- Short Term - Sanitation water (80°C)
  - sanitize 30 min., close valves to isolate housing
  - typically 1 - 2 days
- Intermediate – Chemical Sanitizer Solution (check for compatibility)
  - Oxonia Active (Ecolab, Inc.) – 1% solution
  - Up to 50 days, ambient temperature
- Longer Term - Preserve in 500-1000 ppm sodium metabisulfite
  - Adjust to pH < 5 with citric acid
  - In filter housing - 1-2 days
  - In sealed container - up to 3 months in some cases
  - Check concentration periodically
  - Flush with water prior to reuse

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Membrane Filter Integrity Test

Membrane Filter Integrity Test

- Non-destructive test to determine if the filter is installed and operating correctly.
- Where appropriate, validates retention performance at the rated pore size.
- Three methods
  - Bubble Point
  - Diffusion Flow Test
  - Pressure Hold Test

Integrity Test

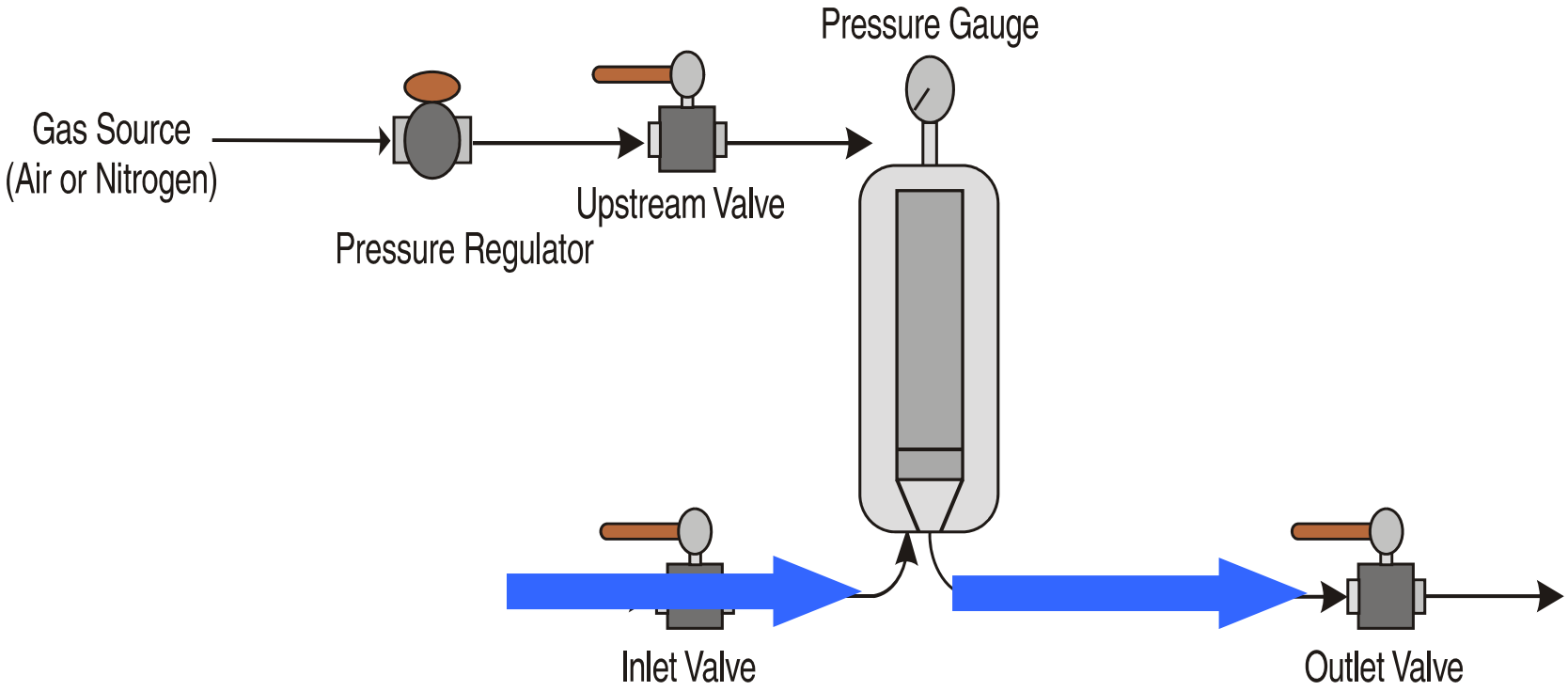
- Pressure Hold test is easiest, fastest, least ambiguous.
- Conduct test manually or with an automated test unit.
- Different membranes have different integrity test parameters.
  - Parameters are influenced by housing volume.
  - Check with supplier for correct values (pressure and allowable drop)
- Wet o-rings with water or wine to allow for easier insertion.

- If a negative test is recorded, consider the following
  - Check O-rings
  - Check the retention rating and filter identity
  - Flush with 2x water, or at 2x the pressure (partially close downstream valve to increase system pressure)

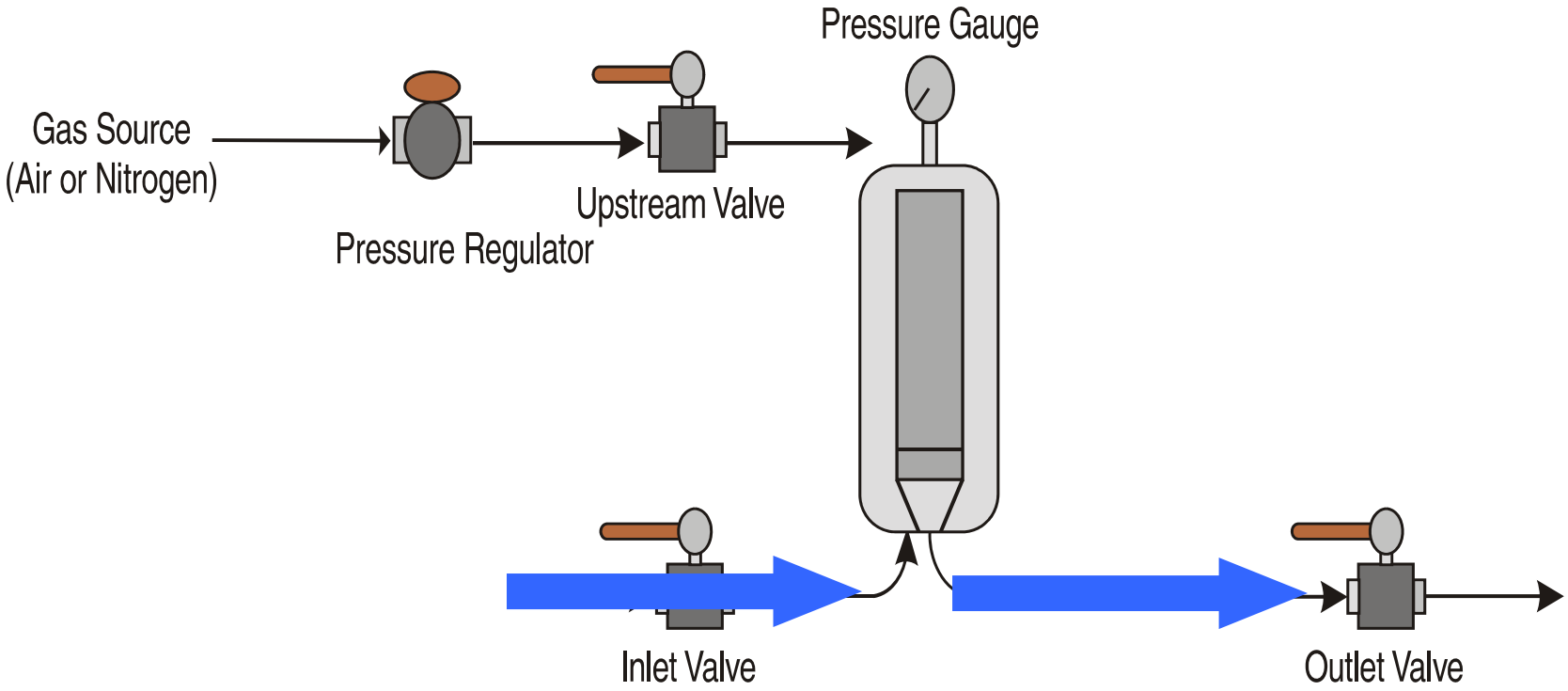
Integrity Test – Pressure Hold

- Measures the pressure decay on the upstream side of the housing.
  - Wet out filter, drain
  - Pressurize upstream side of housing to recommended pressure
  - Close gas valve and open downstream valve, record upstream pressure and time.
  - At 5 minutes, record upstream pressure and consult filter specifications
  - Good integrity – slow diffusion of gas across the membrane
  - Bad integrity – rapid diffusion of gas across the membrane
    - Indicates a fault in the membrane on insufficient wetting

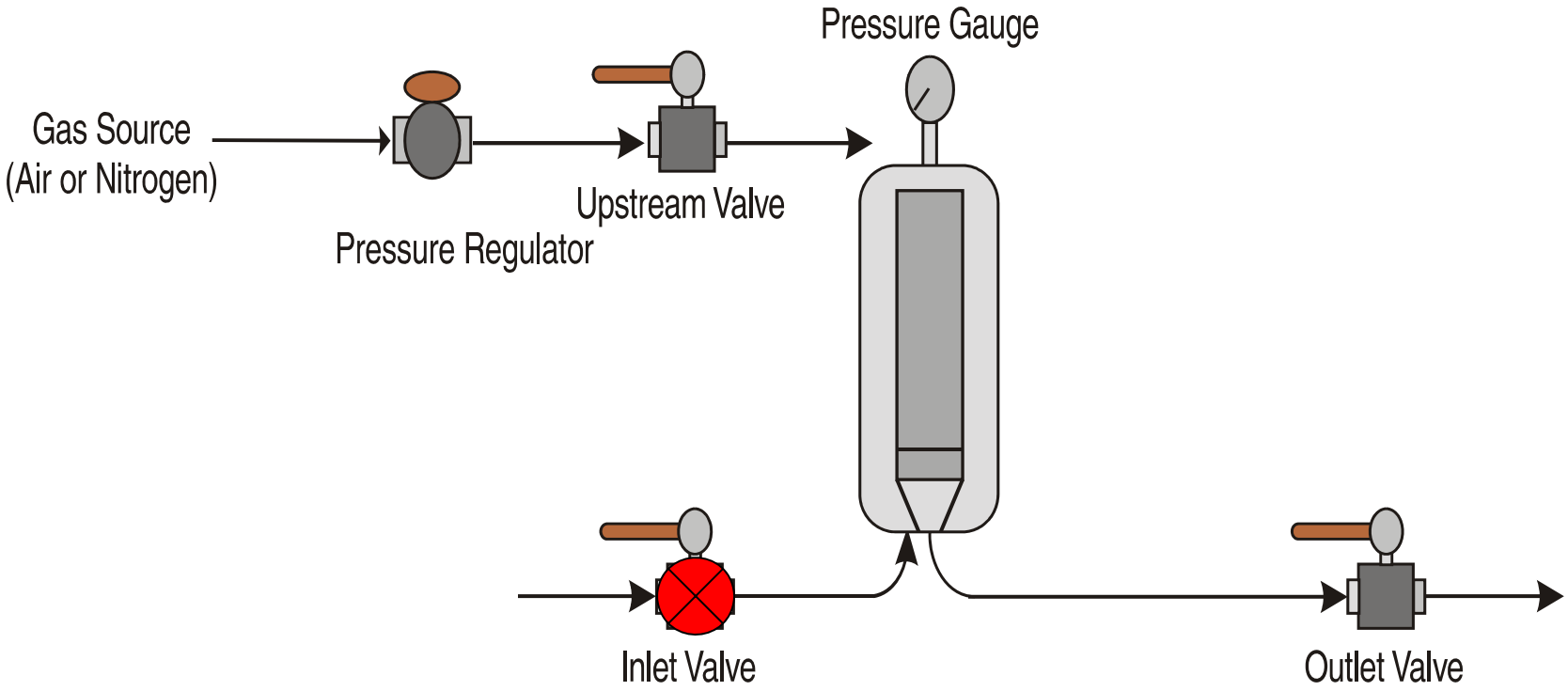
Flush filter with water



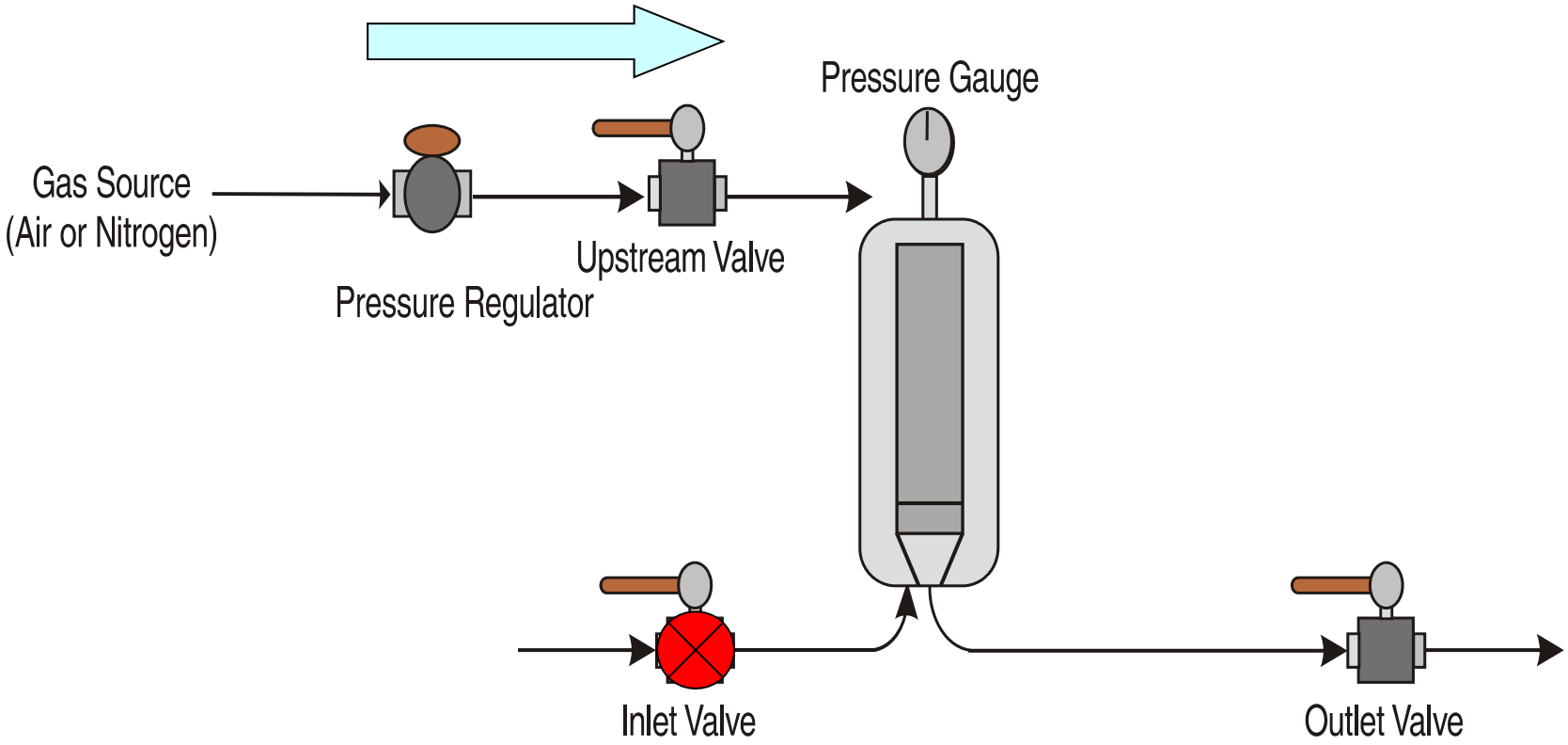
Drain housing



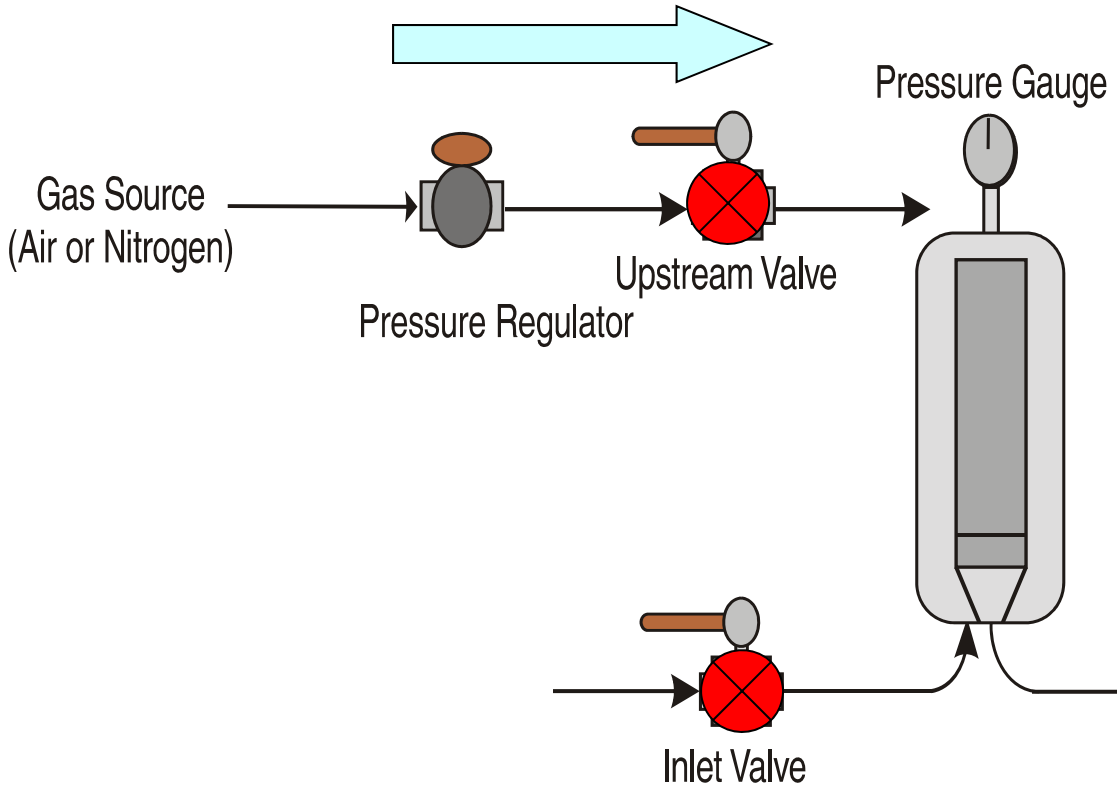
Close upstream valve



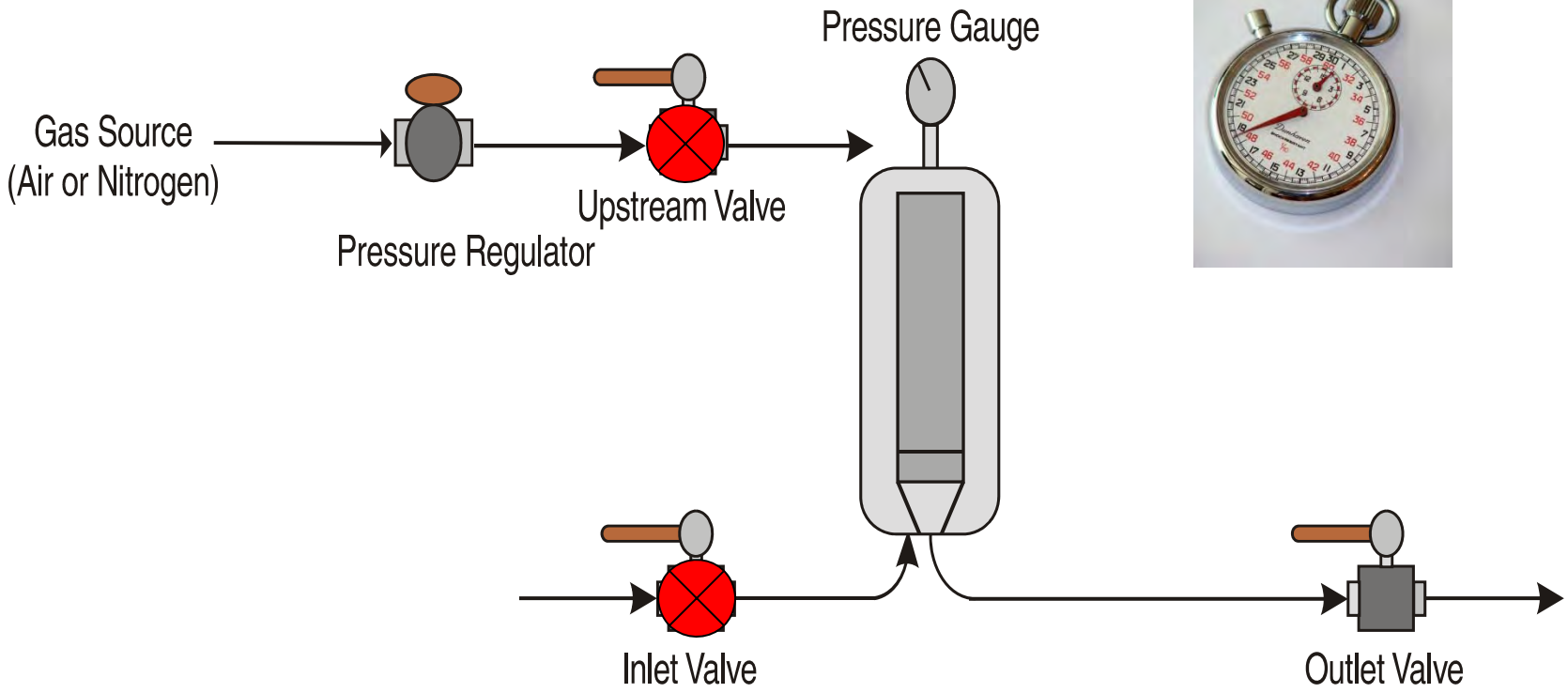
Slowly apply specified gas pressure



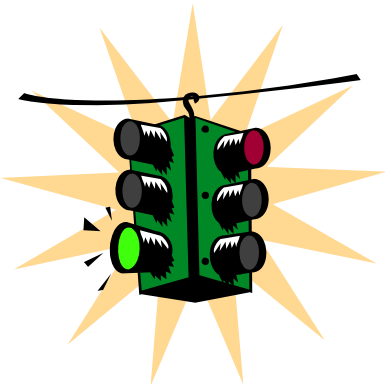
Close gas supply and mark time



At 5 minutes, read pressure gauge



Reading the Pressure Hold Test



- If pressure drop/minute is *less* than manufacturer specification
  - Record result and proceed with filtration

- If pressure drop/minute is *greater* than specified by manufacturer
  - Check O-rings, micron rating, and look for any other damage
  - Leak test housing and fittings upstream of filter
  - Rewet filter (2x flow rate or 2x time)
  - Retest

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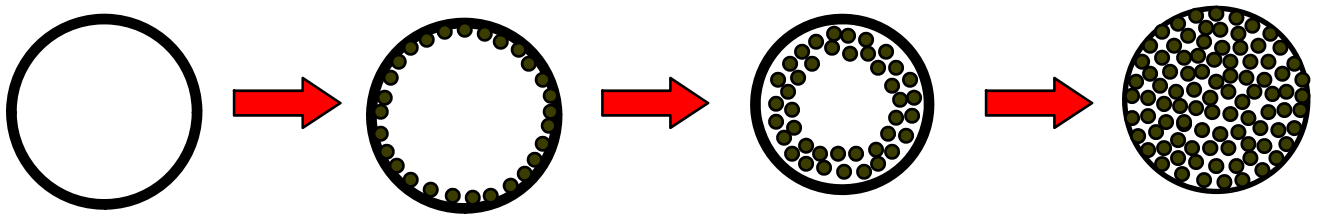
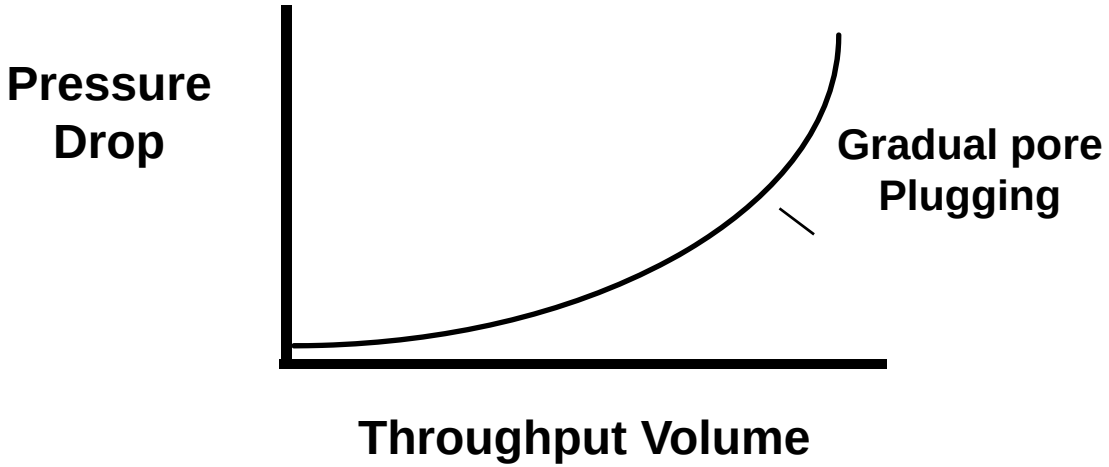
How Filters Plug

and *How to Make them Last Longer*

Gradual Pore Plugging

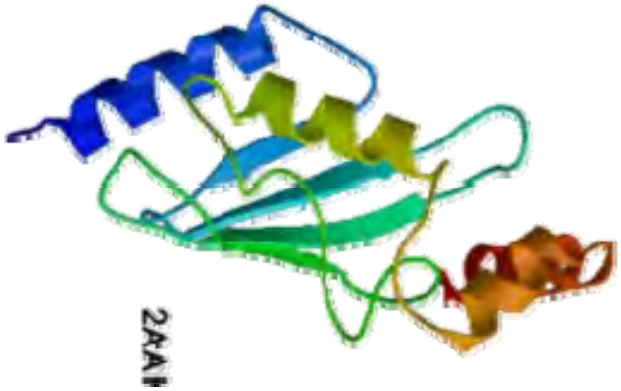


Soft colloid collection on walls of pore



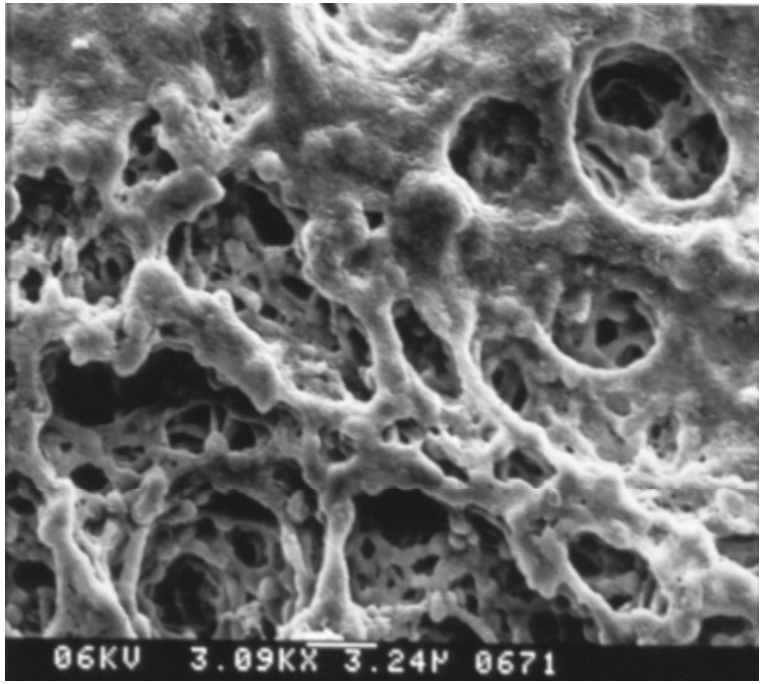
What Plugs Membranes?

- Gradual pore plugging
  - most all wines plug membranes according to this model
  - colloidal carbohydrates gradually collect on the walls of pores until they become obstructed*

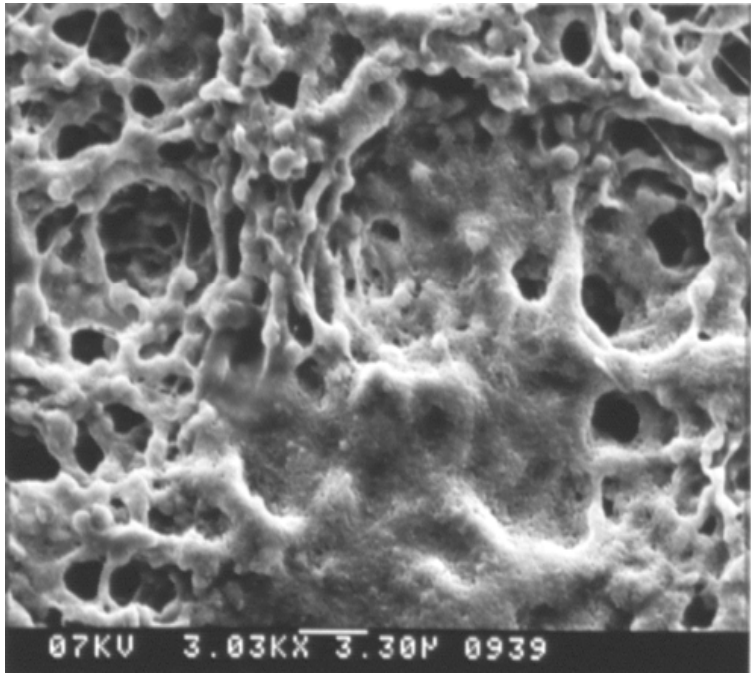


*** Based on *Investigation of Plugging Colloids on Microporous Membrane Filters* , Meier, P.M. et al., ASEV Poster, Anaheim, California, June 29, 1989**

Plugged Membrane Filters



Laboratory Plugged with Glucan-Protein-Tannin



Winery Plugged

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5 Ways to Make Final Filters Last Longer
(and reduce operating costs!)

Increasing Filter Life

- reduction of face velocity

- Face velocity: flow per unit of filter area
  - i.e. - a filter with 10ft^2 of membrane flowing at 2 GPM has a face velocity of 0.2 GPM/ft^2.
- Rule of thumb
  - drop the face velocity by one half and 25% to 30 % more throughput *for area* is achieved

or

  - double the amount of surface area in a system, while keeping the system flow rate constant, will also provide an additional 25% to 30% of throughput
- Rule of thumb: double the cartridges, throughput goes up 2.5X

Increasing Filter Life

- reduction of face velocity

- Why?

  Rice & Screen concept

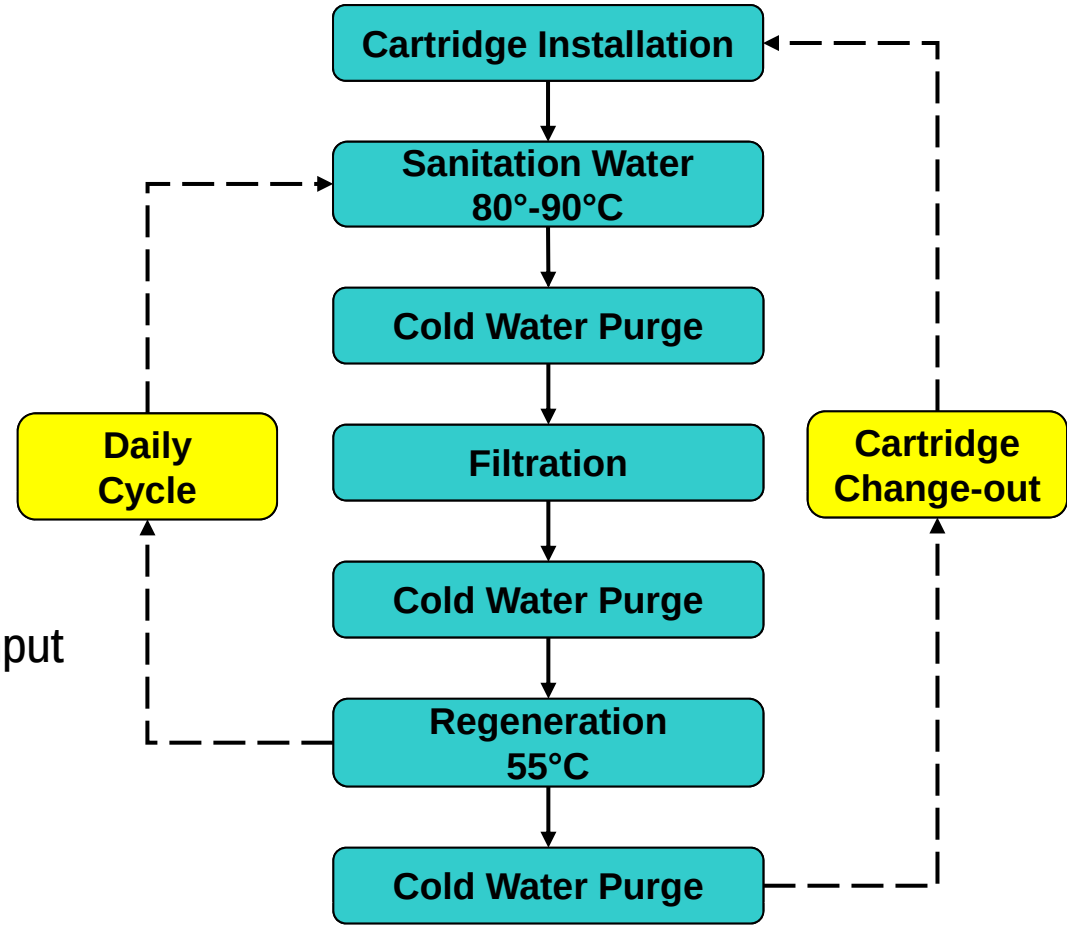
  - Pouring a bag of rice through a screen at a fast rate blocks the screen quickly.
  - Pouring a bag of rice through a screen slowly allows more rice to pass through.
  - Bridging and gradual pore plugging accelerate as flow increases resulting in lower throughputs

Flow slower, or use membrane filters with more surface area per filter

Increasing Filter Life

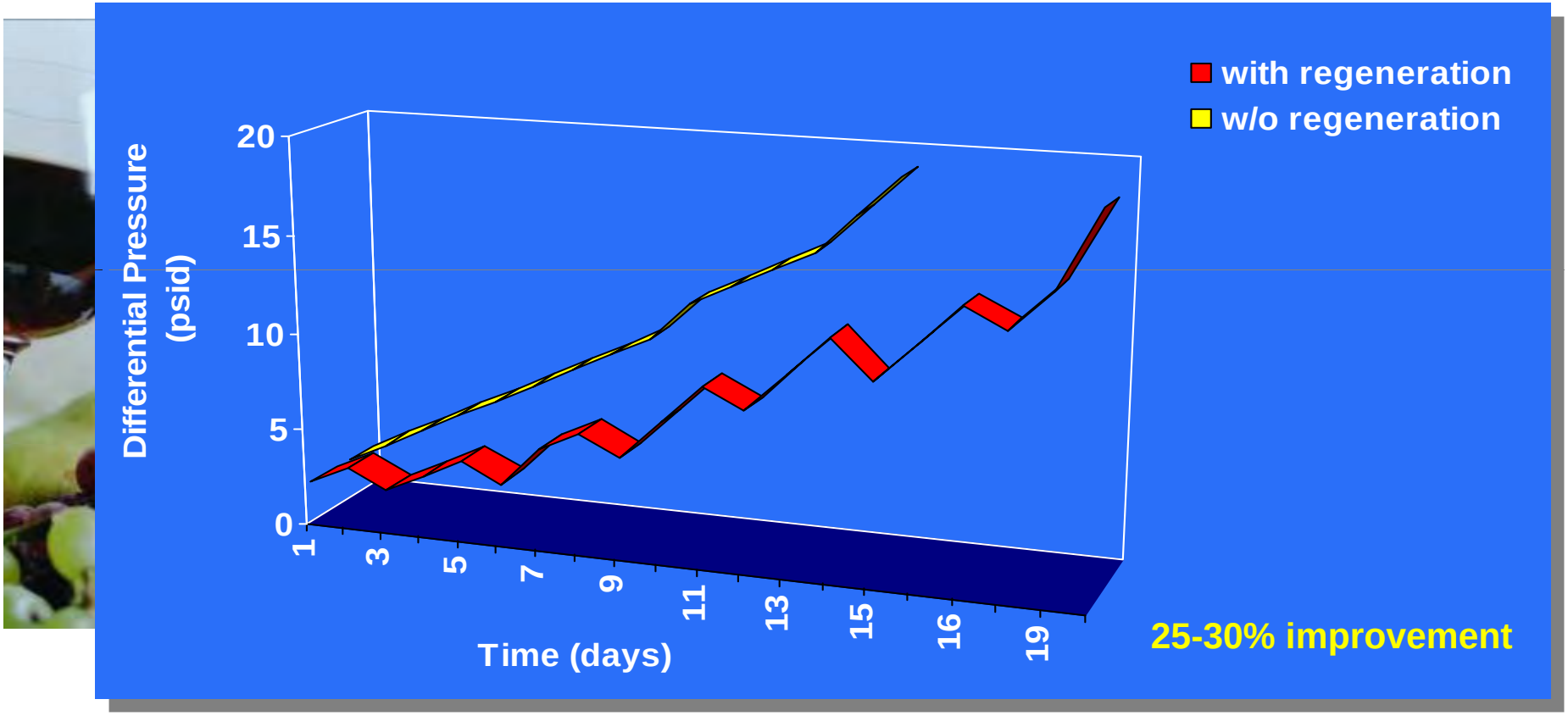
- Warm Water Regeneration

- Warm (55ºC) filtered water flush
  - Conduct *before* sanitation
  - Conduct before dP builds
  - Water *must* be filtered
  - 15 minutes to drain
  - Same flux as filtration run
- Can result in 25-30% more throughput



Note: Regeneration water MUST be flushed to drain and not onto the next filter in series.

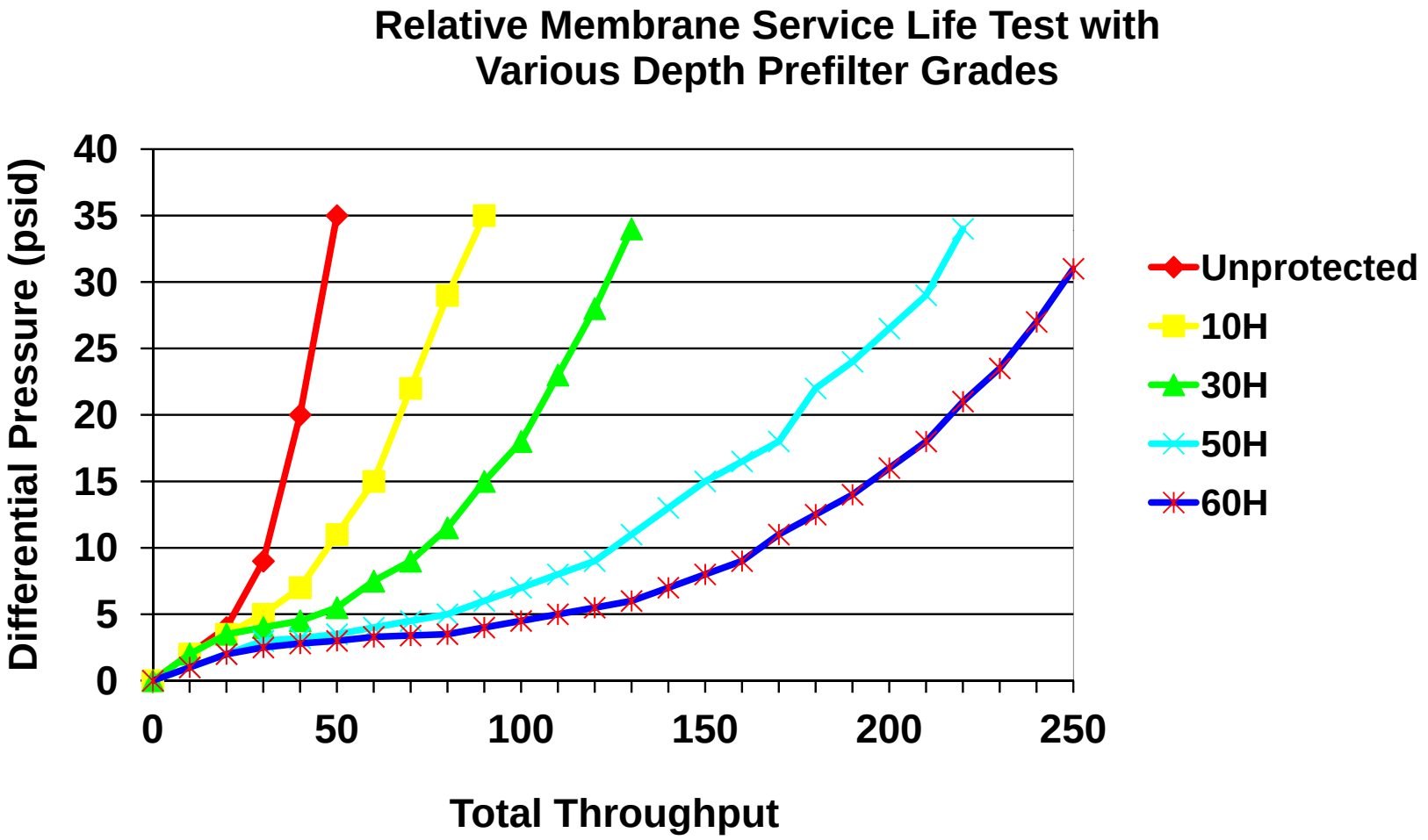
Warm Water Regeneration



Effect of warm water regeneration on filter differential pressure and consequently, filter life.

Increasing Filter Life

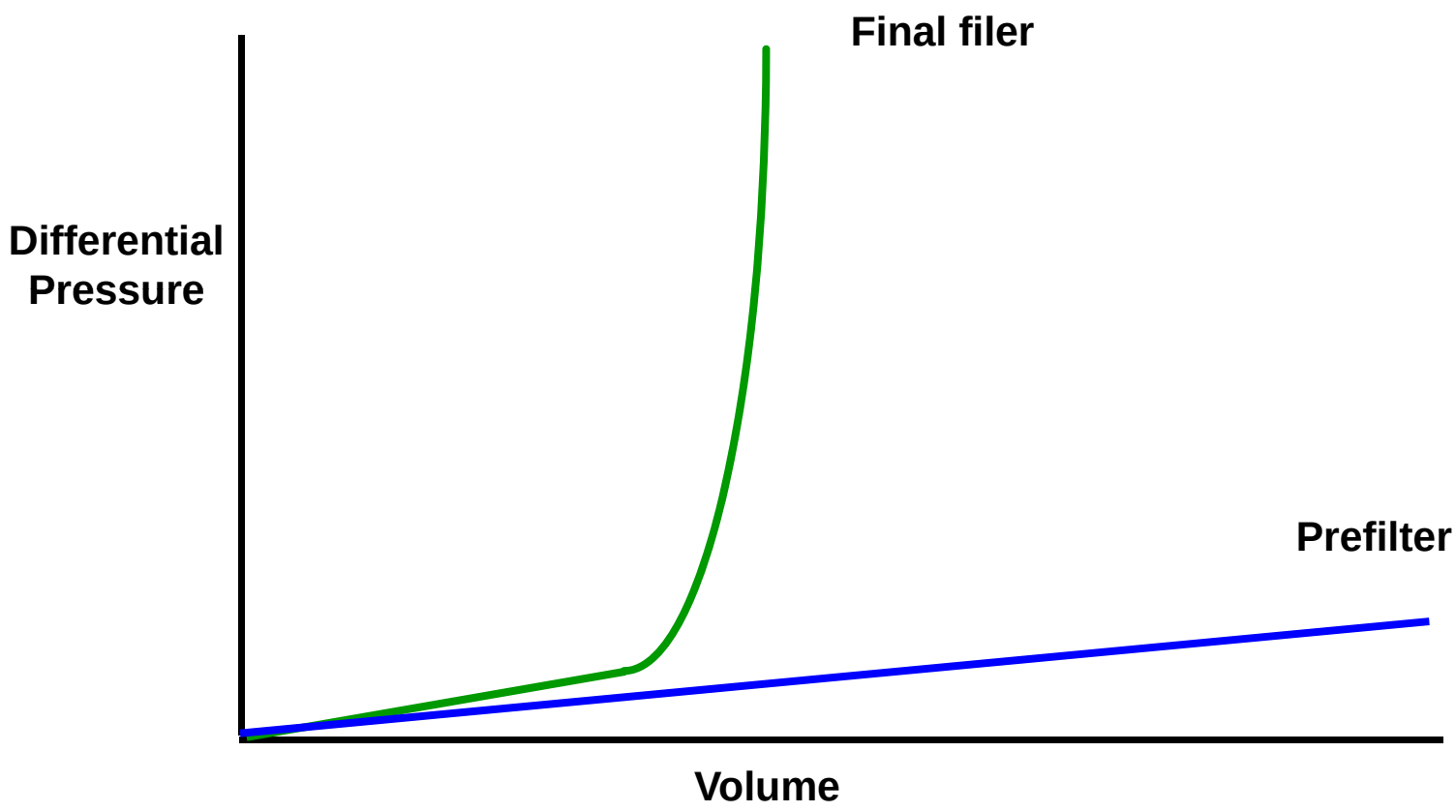
-proper depth filter choice



Increasing Filter Life
- a balanced system

- Filters are typically changed base on achieving a terminal differential pressure across the filter (usually 20-35 psid)
  - This indicates that they are plugged and must be changed
- Filters that do not exhibit differential pressure at all are not helping!
  - If there is no dP build-up, it is not removing anything!

Unbalanced system – *favors prefilters*



Increased cost/gallon, change-outs, system downtime

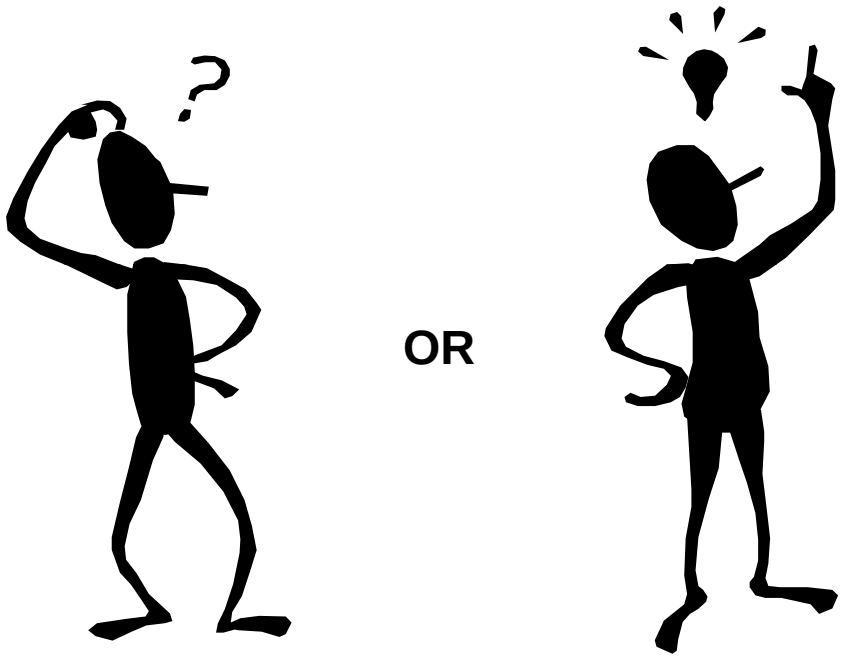
Increasing Filter Life

- Preparing the Wine

- Final membrane filtration is really an insurance policy against spoilage and refermentation
- Wine should be free of noticeable turbidity
  - Combination of racking, fining agents, DE/cross flow, depth filtration
- Using final membrane filters for clarification is not economical

Conclusion

- Use membrane filters only when needed
- Prepare the wine for filtration
- Select membrane filters that are made for wine filtration, are integrity testable, durable, and have demonstrated retention.
- Pressure hold integrity test is the easiest and fastest integrity test.



Thank You!

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