Separation Anxiety

Observational Insights
to Understanding Wine Filtration

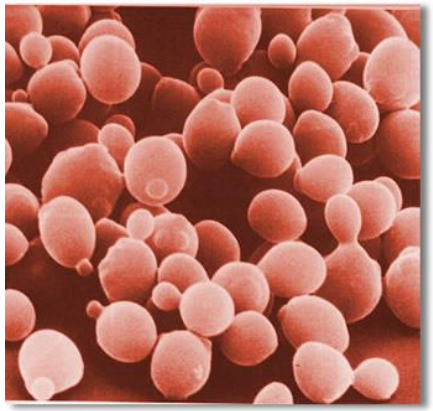
SCOTT LABORATORIES

Filtration Goals

-Clarity

-Stability

-Efficiency



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Scott Labs' Specialty

- Filtration sales since 1965
- 90% of our filters used in winemaking
- Global awareness of process
  - Fermentation
  - Packaging
  - Bottling

- Our concern is for the wine, not for the filter.

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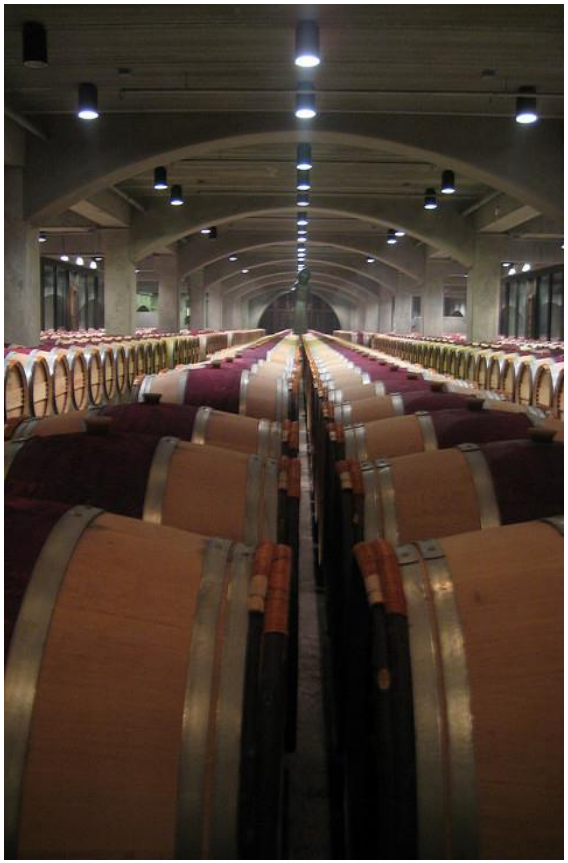
The Winemaking Process



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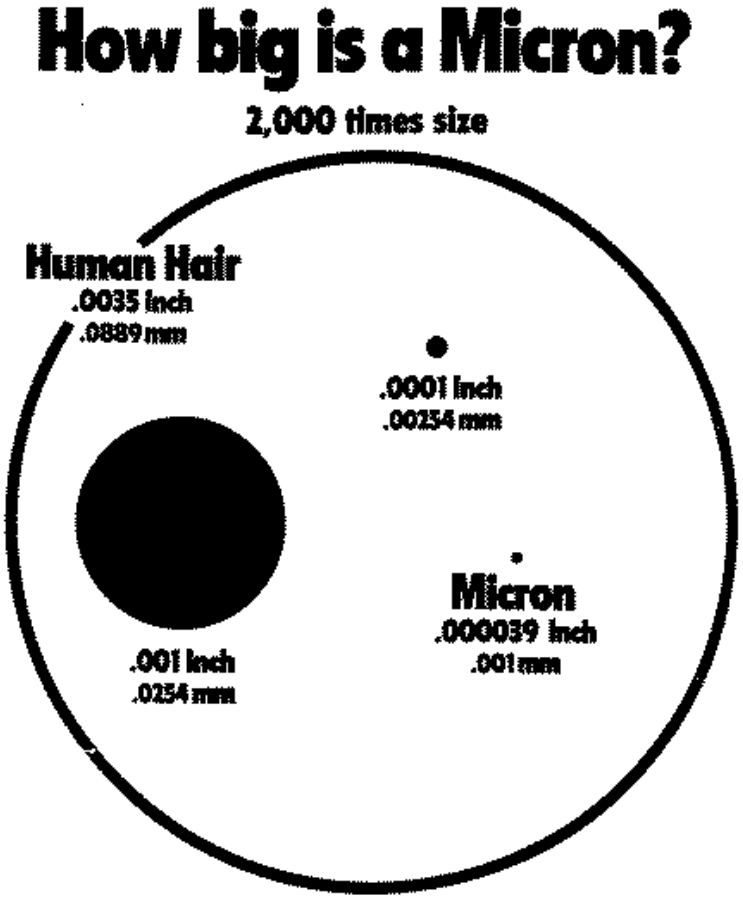
Micron or µm



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Suspended Solids

- Grape pulp – 20 to 200 micron, gelatinous
- Tartrate crystals – 5 to 500 micron, rigid
- Protein precipitates – 2 to 20 micron, gelatinous
- Yeast – 1 to 2 micron, gelatinous
- Bacteria – 0.6 to 0.8 micron

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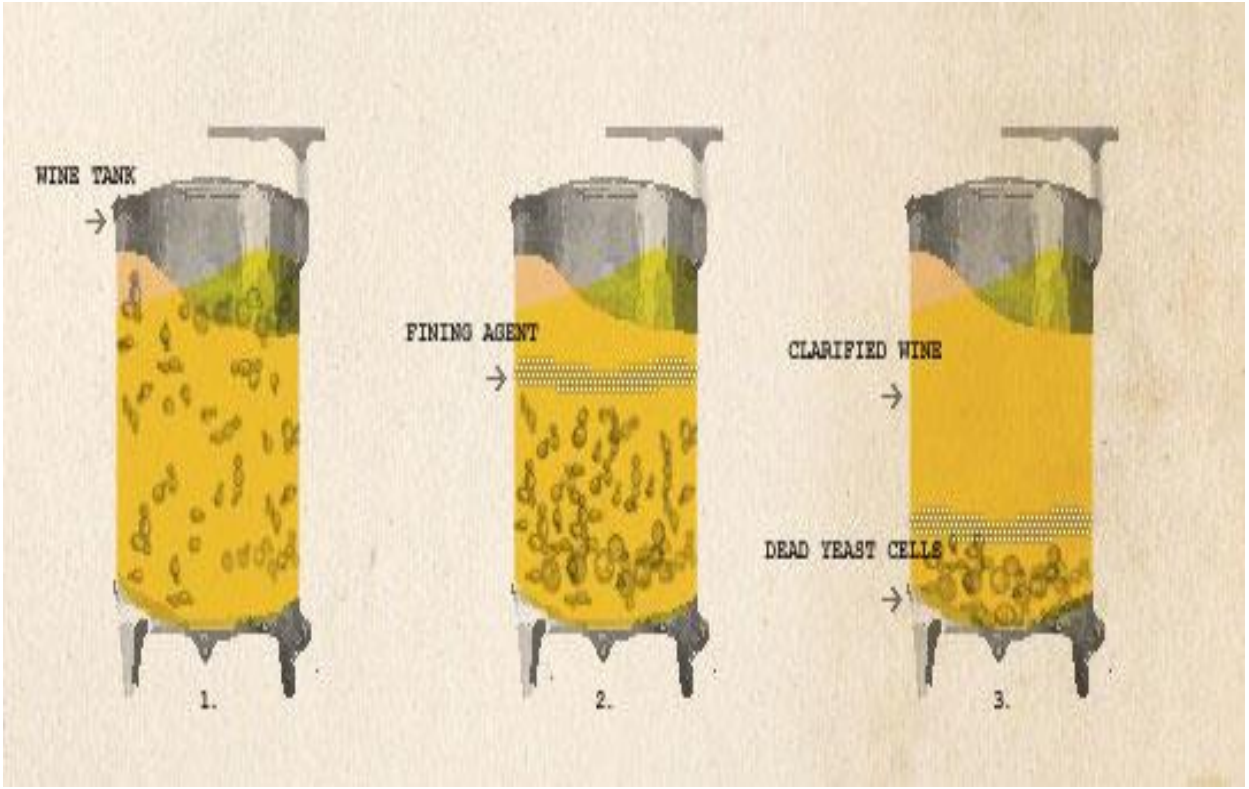
Clarification and Stabilization



Fining agents

Temperature

Gravity

Racking

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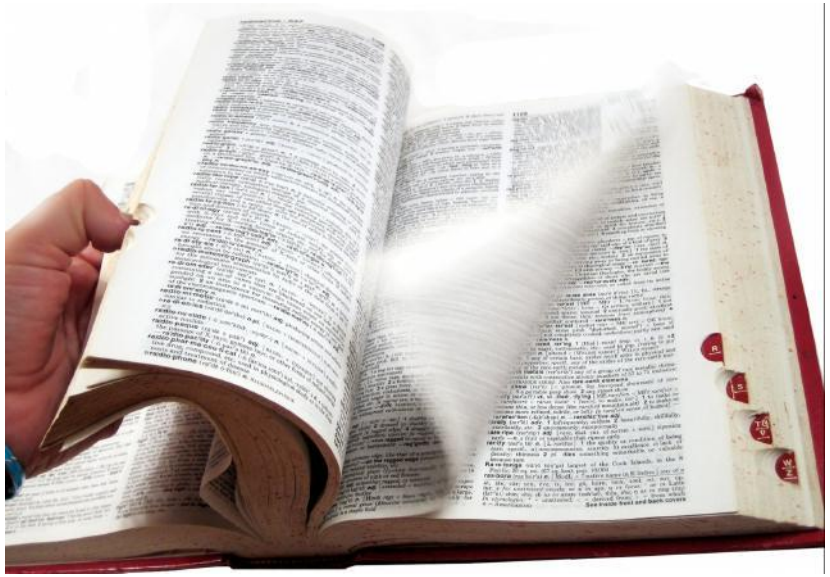
Glossary

- Depth and Membrane Filtration
- Absolute/Nominal
- Rough, Polish & Sterile
- Integrity testable



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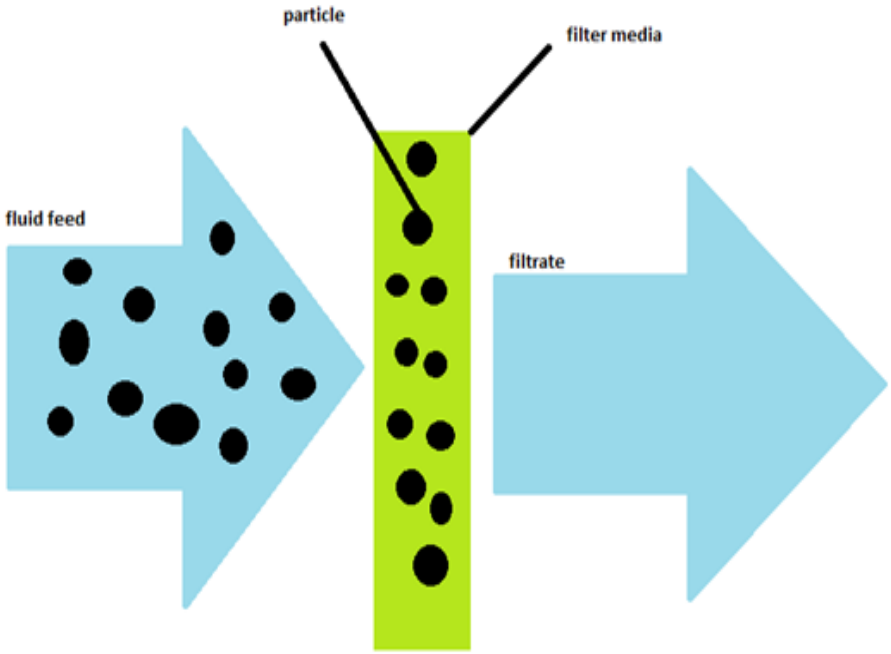
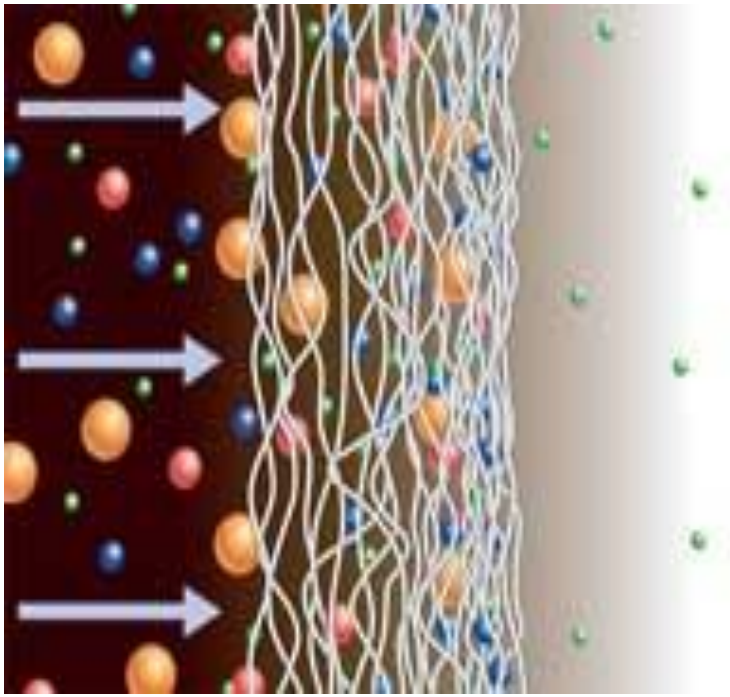
How does depth filtration work?





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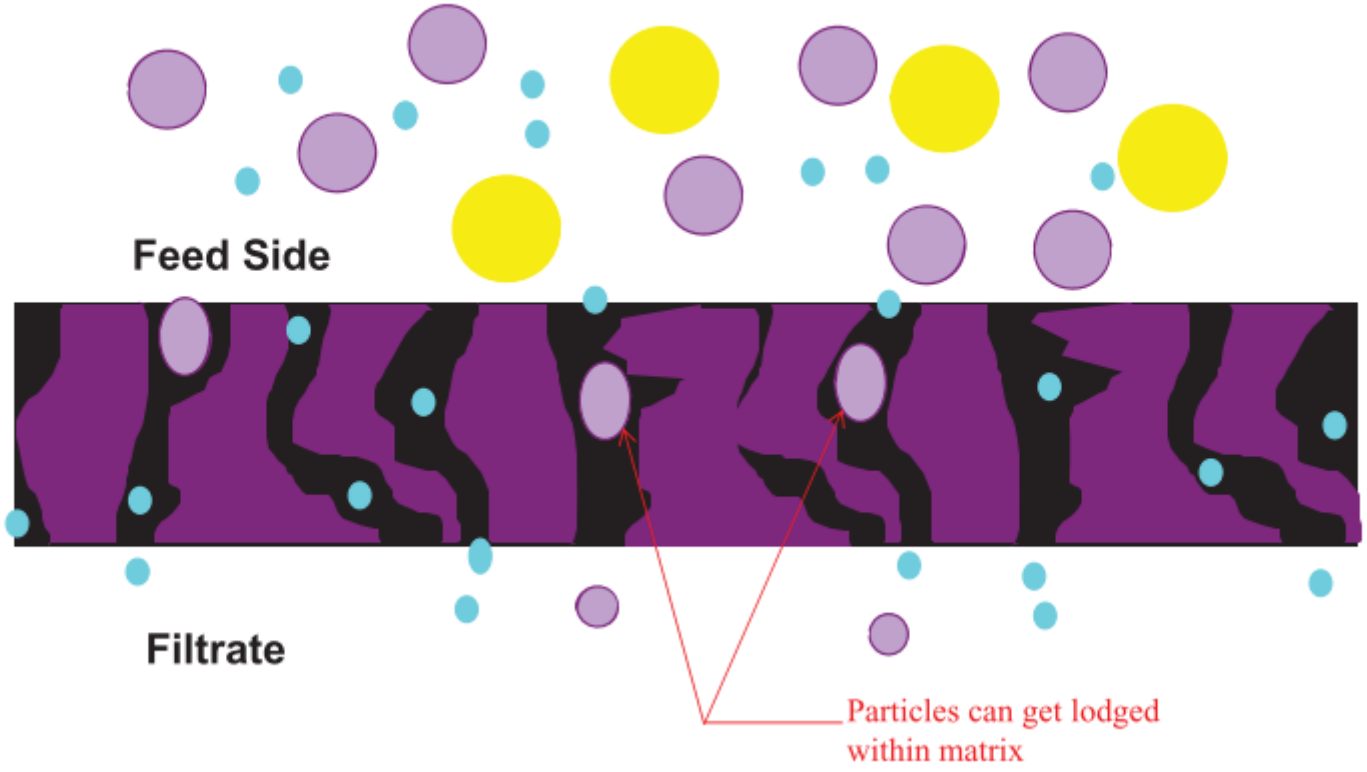
The labyrinth or tortuous path



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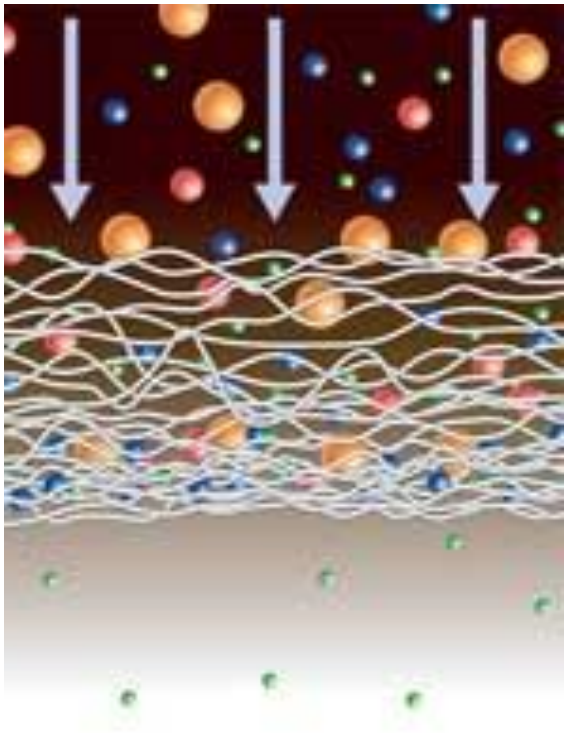
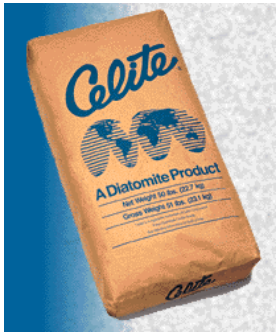
Depth Filtration



- Goal – Removing Solids
- “Dirt holding capacity”

- Example: Filter pad media ; DE Filtration ; PP cartridges.



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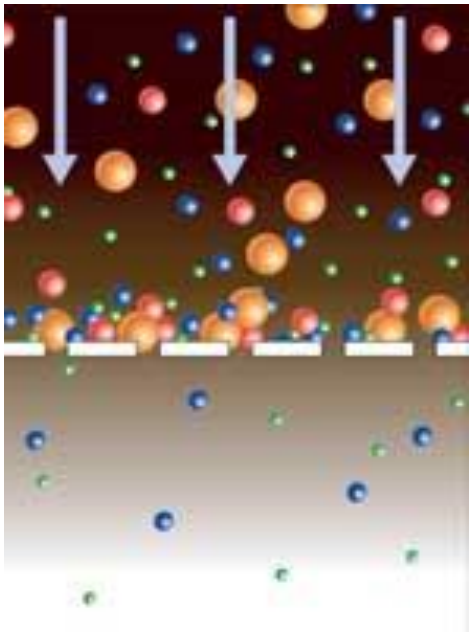
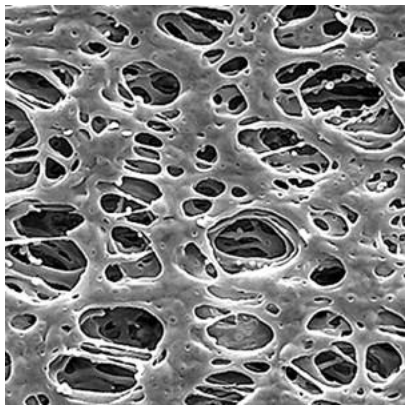
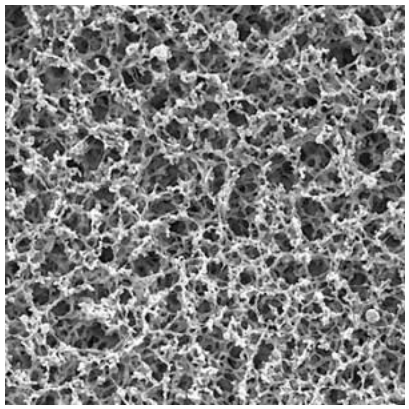
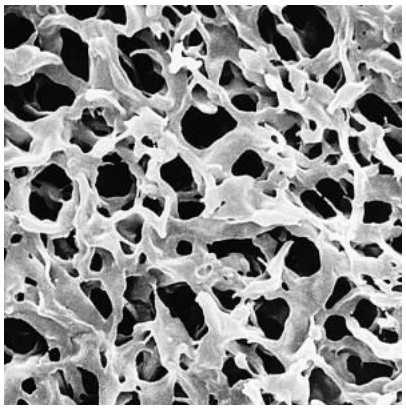
Membrane Filters

- High precision / accuracy
- Very low dirt holding capacity
- Examples: X-Flow, PES, PVDF, Glass matrix. Cellulose Acetate









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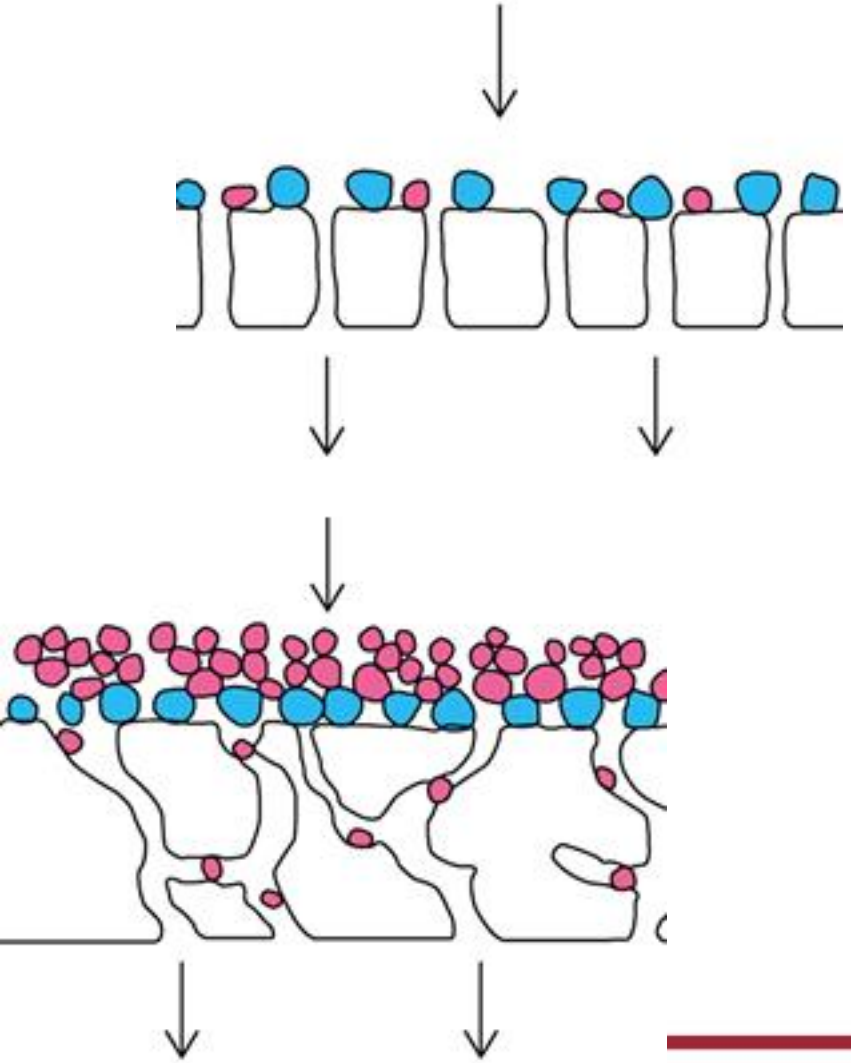
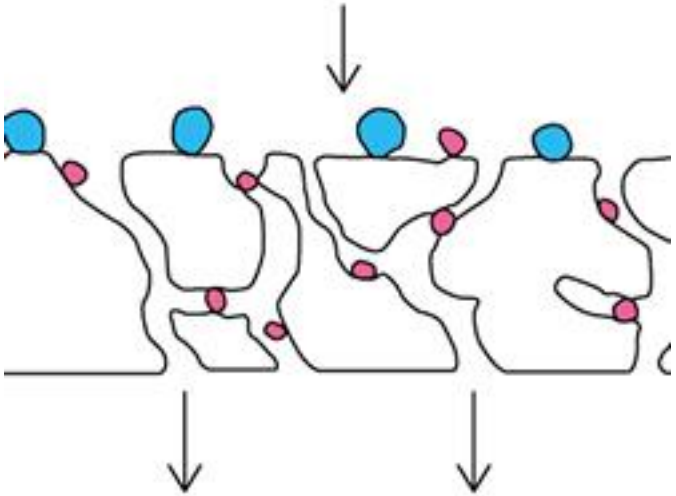
Different paths





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Oenococcus oeni on membrane surface

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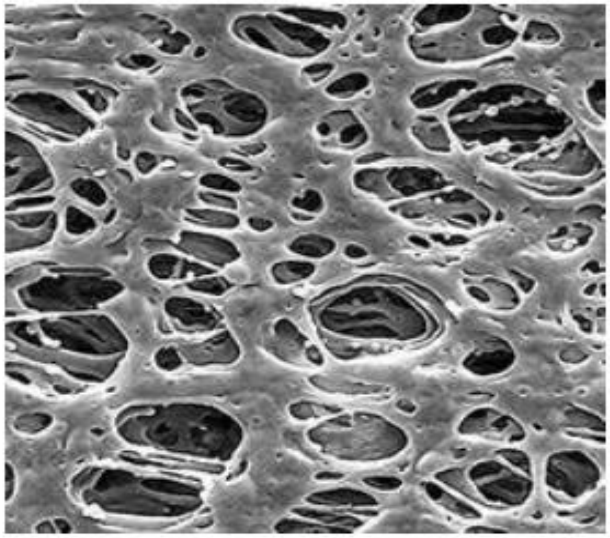
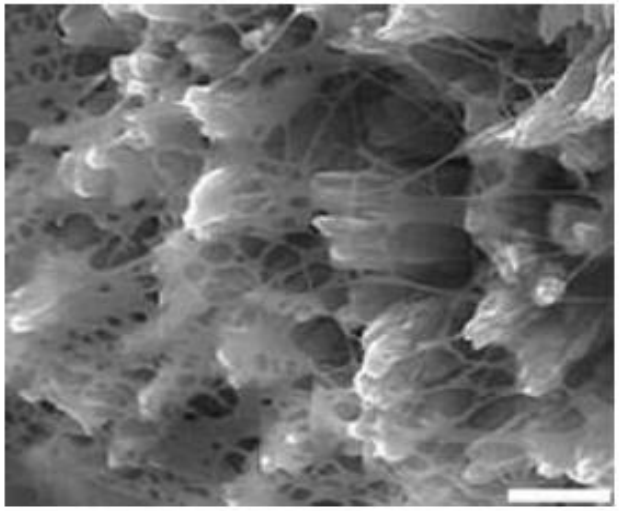
Glucans

Clean PES membrane



PES membrane fouled with glucans from *Botrytis*



ue H2O
tration

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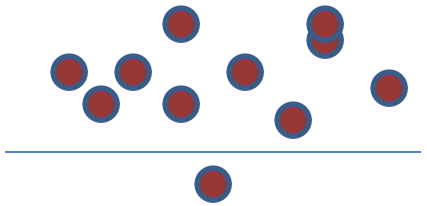
“Nominal vs Absolute”

- Beta ratings

$$\beta_X = \frac{n_{Upstream} \geq X\ \mu m}{n_{downstream} \geq X\ \mu m}$$



$= 10$

- Testing methodology
  - Typically spherical Glass or Nylon beads of a determined size passed under lab pressures
- Nominal = NOT absolute
- Absolute = maximum sized glass sphere (Absolutely nothing larger than the micron rating will pass through the membrane)

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Titer Reduction Values

- Goal-based classification
- The best current method to distinguishing between similar but different filters
- 10^6 vs 10^9

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Absolute/Nominal vs. Titer Reduction Value

– **Two Filter Carts. Same grade, different Titer value:**

- **Seitz XLII 0.45**
- **10^9** reduction of *Serratia marcescens*
- 99.9999999% reduction

- **Brand X 0.45**
- **10^6** reduction of *S. marcescens*
- 99.9999% reduction

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Example #1

- Take an example of a wine exhibiting 100,000 cells/ml. Expect the following for the Seitz XLII 0.45:
- Reduction of 99.9999999% at 10^9 would yield 0.0001 cells per ml **OR**:
- .075 bugs per bottle

100,000 cells/ml	750 ml/bottle
x 0.000000001	x 0.0001 c/ml
0.0001 cell/ml	**0.075 cells/bottle**

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Example #2

- Now try Brand X 0.45 with a titer reduction of 10^6 at :
- Reduction of 99.9999% would yield 0.1 cells per ml **OR**:
- 75 bugs per bottle

100,000 cells/ml	750 ml/bottle
x 0.000001	x 0.1 c/ml
0.1 cell/ml	**75 cells/bottle**

Is this an important difference ? Maybe.

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Rough, Polish and Sterile

ROUGH	POLISH	STERILE/SANITIZING
Greater than 5 micron	Between 1-5 micron	Less than 1 micron
-Turbidity reduction -Excessively cloudy -Visible solids removal -Heavy Yeast removal	-Brightness -Final clarity -Yeast Population reduction	-Brilliance -Yeast “sterility” -Bacteria log reduction or “sterility”
DE: 1 Darcy **Lenticular & Pads:** K700 and up **Cartridges**: Polypropylene	**DE:** 0.3-0.4 Darcy **Lenticular & Pads:** K100 through K300 **Cartridges**: Glass or PP	**DE:** 0.1-0.2 Darcy **Lenticular & Pads:** EKS through KS80 **Cartridges**: PES

HUMAN HAIR: 55 µ Common PVPP: 25 µ Saccharomyces: 1-5 µ Oenococcus: 0.5-1 µ

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Filtration options

- Pads
- Lenticular
- DE Filter
- X-Flow
- Cartridge

POWER

WINE LOSS

CAPITAL

MEDIA COST

LABOR

DISPOSAL

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Filter Pads

- Preformed Depth Filters
- Rated from 0.2-55 microns
- Cellulose, DE, Perlite, Resin (or some combo)

- Pro: Pre-formed; repeatable; low capital costs
- Neutral: Medium media cost
- Con: Leakage loss; Disposal; Setup time; Space

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Plate & Frame Filter

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Assumed Conditions* – Pad Media

- Average filter capacity period: 2 hours
- Optimal flow rate per m^2 pad media
  - Sterile: 125 gal/hr/m^2
  - Polish and rough: 220 gal/hr/m^2
- Example: 2500 gallons of red wine to polish

$$\frac{2500\ \text{gal}}{2\ \text{hours}} \rightarrow 1250\ \text{gal/hr} \rightarrow \frac{1250\ \text{gal/hr}}{220\ \text{gal/hr/m}^2} \rightarrow 5.68\text{m}^2 \rightarrow \frac{5.68\text{m}^2}{.16\text{m}^2\ \text{Per 40x40}}$$

RECOMMENDED USE OF AT LEAST 36 40X40 FILTER SHEETS

*This reality does not exist

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Filter pad regeneration

- 15 minute cold water forward flow
- 15 minute warm water (110F) forward flow
- 20-30 minutes sanitizing with 180F water
- Cool down the pads (slowly) after sanitizing otherwise microbes will breed overnight. (at 78 – 115F you can increase the population from 1 cell to 4 trillion overnight.)

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Efficiency Tips - Pads

- Pre-rinse cycles
  - 2.0 pH with Citric and up to 1000ppm SO2
- DO NOT MIX GRADES WITHOUT CROSSOVER
- Replace “H” Gaskets every two years OR when hardening of rubber occurs
- Regeneration
  - Forward flushes of 120F
  - If Backflush, DO NOT exceed 7PSI
- Use 2-stage filtration when possible

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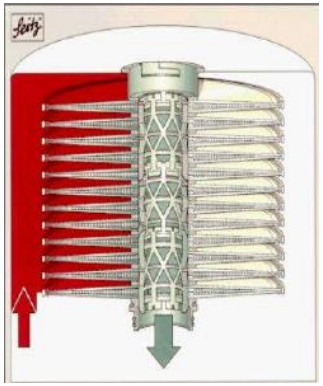
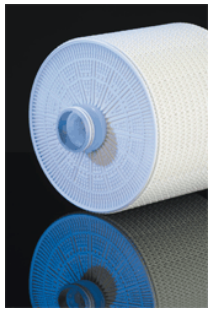


Lenticular Filters



- THE SAME MEDIA AS PADS
- Modular format with 2 adapter types
- Pro: Quick setup/breakdown; repeatable; low capital costs; some backflushable; storable; **VERY LOW LOSS**
- Con: Higher upfront media costs; disposal

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Lenticular Filter

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Efficiency Tips - LENTICULAR

- Be flexible with housings
  - Size filtrations to minimize cost/filtration
- Regeneration
  - Forward flushes of 120F
  - If Backflush, DO NOT exceed 7PSI (use backflush plate for maximum support and efficiency)
- 12” vs 16” modules.
- Different height center posts, dual grade modules.

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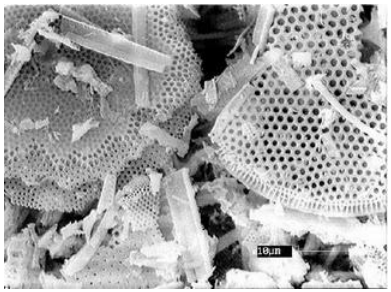
DE (or Perlite) Filtration

- Very high dirt holding capacity
- DE or Perlite Earth used
- Continuous addition of media creates capacity



- Pro: Low cost media; very high DHC
- Con: High capital costs; labor intensive; disposal; safety concerns

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Assumed Conditions* – DE Media

- Average filter capacity period: 2 hours
- Setup/Breakdown is 1.5 hours
- Optimal flow rate per m^2 filter surface: 300 gal/hr/m^2
- 8 hour work day, trained operator
- Example: Average lot size is 6,000 gallons

$$\frac{6000 \text{ gal}}{2 \text{ set ups}} \rightarrow \frac{3000 \text{ gal}}{2 \text{ hours/ setup}} \rightarrow \frac{1500 \text{gal/hr}}{300 \text{ gal/hr/m}^2} \rightarrow 5\text{m}^2$$

A $5m^2$ filter should allow for 6,000 gallons to be filtered in 7 hours including setup/breakdown

*This reality does not exist

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Cartridges

- Very low dirt holding capacity
- Very high precision and accuracy
- Often polymer based and sold for “T-style” housings in our industry (single open end)
- PRO: Standard for bottling; repeatable; regenerable; storable; high filterable surface
- CON: Poor for high solids; High media cost

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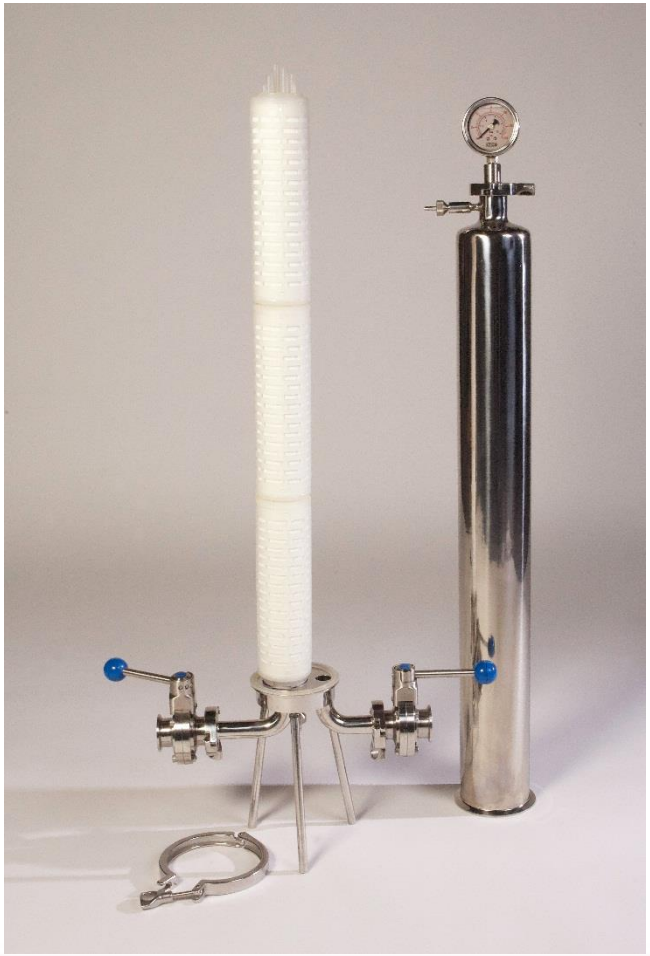
Cartridge Filter & Housing



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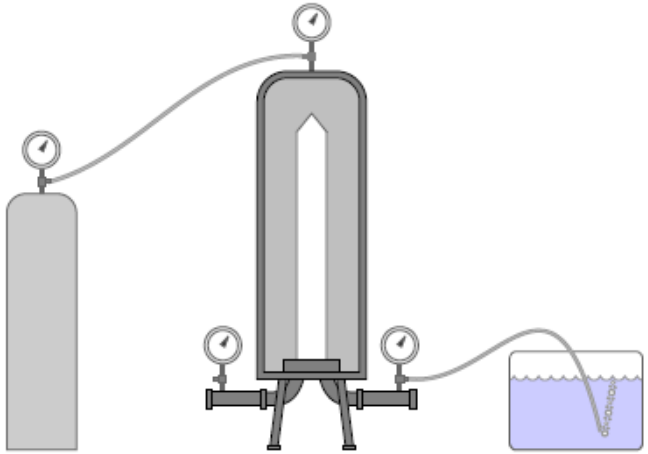
Integrity Testable

- IS THERE A **HOLE** IN MY FILTER!?
- Tests
  - Pressure diffusion
  - Bubble point
  - Pressure hold
    Same physics. Differs
    in which part of flow spectrum they examine.



- These tests should be preformed BEFORE and AFTER a filtration on membrane filters <1 micron.

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Bubble point procedure

- See video at scottlabs.com
- Wet the filter with the appropriate fluid – water.
- Pressurize the system to about 80% of the expected bubble point pressure which is stated in the manufacturer's literature. Slowly increase the pressure until rapid continuous bubbling is observed at the outlet.

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Trouble shooting

- If the bubble point value is lower than the specification then the following:
- Fluid with different surface tension than recommended test fluid. Gas choice?
- Integral filter but wrong pore size
- High temperature
- Incompletely wetted membrane
- Non integral membrane or seal.

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Efficiency Tips - Cartridges

- REGENERATE AND STORE
  - Decrease expenses
  - Regenerate with KOH and store in EtOH (cheap vodka) or a pickle of Acid and SO2.
- If storing in SO2, remove gaskets
- In line Regeneration
  - Forward flushes of 130F
  - Backflush depth filters, but use hold-down or Code 7
- Do not wait more than 24 hours after “pre-filtration”
- Integrity test membranes BEFORE AND AFTER

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Cost Analysis

- Power
- Labor cost
- Media
- Capital
- Wine Loss

Power Cost (kw/hr)	$0.14	
Operator Wage	$18.00	
Wine Cost Per Gallon	$12.00	
X Flow Elements	3	
X Flow Filtration Rate	300	gal/hr
X Flow Unit Cost	$65,000	
Replacement Element Cost	$5,000	
Estimated Life of Elements	220,000	gal/elm
Pressure Leaf Size	3	sq m
P.L. Filtration Rate	927	gal/hr
P.L. Cost	$12,000	
Filtration passes	1	
Plate and Frame Size	40	plates
40x40=40 60x60=60	40	
Surface Area	6.4	sq m
Flow rate	1320	gal/hr
Plate and Frame Price	$7,800	
Filtration passes	2	
Gallon capacity per sq m	425	
Lenticular Filter Hieght (1-4)	3	high
12" Diameter =12 16"=16	12	
Surface area	5.4	sq m
Flow rate	1113.75	gal/hr
Plate and Frame Price	$5,000	
Filtration Passes	2	
Gallon capacity per sq m	531.25	

Gallons M	Total Xflow Cost	Filter Time	Total PL Cost	Filter Time	Total PF Cost	Filter Time	Total PF Cost
20	$66,536.68	27.0	$13,701	47.2	$12,189	40.8	$15,822
40	$68,073.36	48.5	$15,312	92.3	$16,265	79.9	$18,589
60	$69,610.04	70.1	$16,923	137.5	$20,476	119.1	$23,967
80	$71,146.72	91.7	$18,534	182.6	$24,687	158.2	$29,344
100	$72,683.39	113.3	$20,145	227.8	$28,898	197.4	$34,722
120	$74,220.07	134.8	$21,756	272.9	$33,109	236.5	$40,099
140	$75,756.75	156.4	$23,367	320.1	$37,364	277.3	$45,511
160	$77,293.43	178.0	$24,978	365.2	$41,575	316.4	$50,889
180	$78,830.11	199.6	$26,589	410.4	$45,786	355.6	$56,266
200	$80,366.79	221.1	$28,200	455.5	$49,997	394.7	$61,643
220	$81,903.47	242.7	$29,811	500.7	$54,208	433.9	$67,021
240	$83,440.15	264.3	$31,422	545.8	$58,419	473.0	$72,398
260	$84,976.82	285.9	$33,033	591.0	$62,630	512.2	$77,776
280	$86,513.50	307.4	$34,644	638.1	$66,884	552.9	$83,188
300	$88,050.18	329.0	$36,255	683.3	$71,095	592.1	$88,565
320	$89,586.86	350.6	$37,866	728.4	$75,306	631.2	$93,943
340	$91,123.54	372.2	$39,477	773.6	$79,517	670.4	$99,320
360	$92,660.22	393.7	$41,088	818.7	$83,728	709.5	$104,698
380	$94,196.90	415.3	$42,699	863.9	$87,939	748.7	$110,075
400	$95,733.58	436.9	$44,310	911.0	$92,194	789.4	$115,487
420	$97,270.25	458.5	$45,921	956.2	$96,405	828.6	$120,864
440	$98,806.93	480.0	$47,532	1001.3	$100,616	867.7	$126,242
460	$100,343.61	501.6	$49,143	1046.5	$104,827	906.9	$131,619
480	$101,880.29	523.2	$50,754	1091.6	$109,038	946.0	$136,997
500	$103,416.97	544.8	$52,365	1136.8	$113,249	985.2	$142,374
520	$104,953.65	566.3	$53,976	1181.9	$117,460	1024.3	$147,752
540	$106,490.33	587.9	$55,587	1229.1	$121,714	1065.1	$153,164
560	$108,027.01	609.5	$57,198	1274.2	$125,925	1104.2	$158,541
580	$109,563.68	631.1	$58,809	1319.4	$130,136	1143.4	$163,918
600	$111,100.36	652.6	$60,420	1364.5	$134,347	1182.5	$169,296
620	$112,637.04	674.2	$62,031	1409.7	$138,558	1221.7	$174,673

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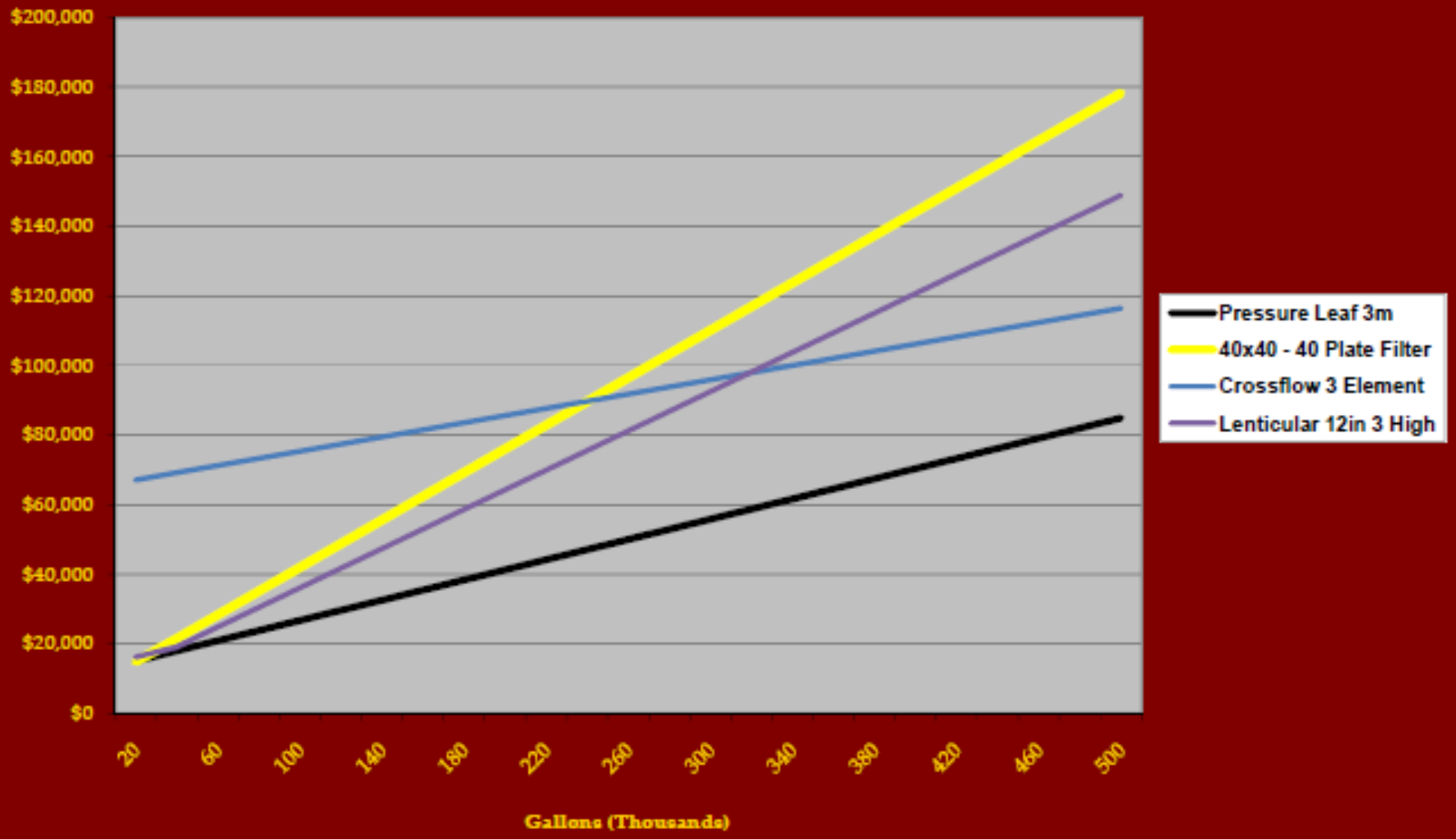
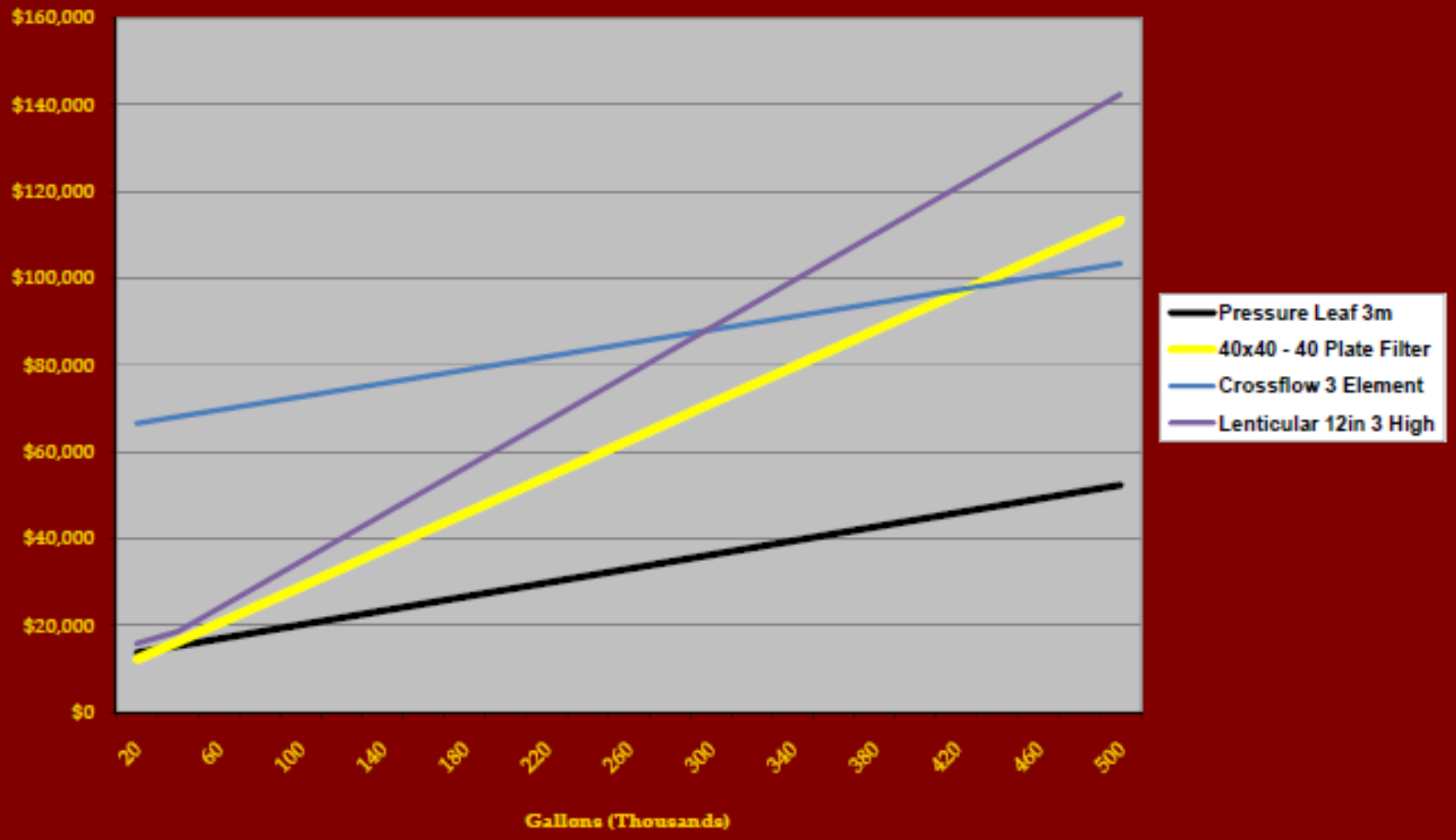
$25/GALLON SCENARIO

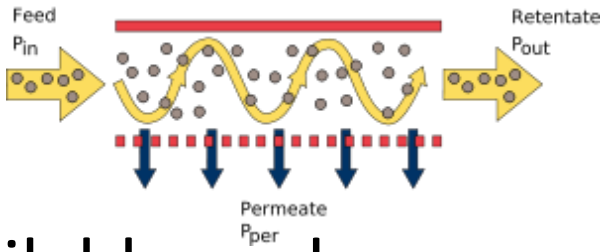


$12/GALLON SCENARIO

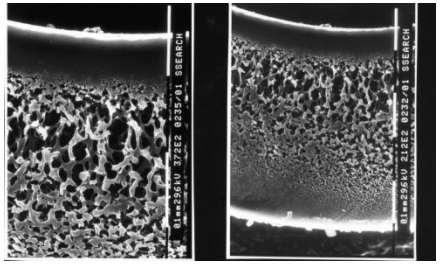


Crossflow

- High Efficiency filtration of wide range of %solids wine
- Employs tangential flow which minimizes permanent fouling
- NOT STERILE FILTRATION



- PRO: Single stage; automation available; reduces handling; low disposal and wine loss
- Neutral: Media cost medium to high
- CON: Capital cost high; media is not indestructible; requires good training



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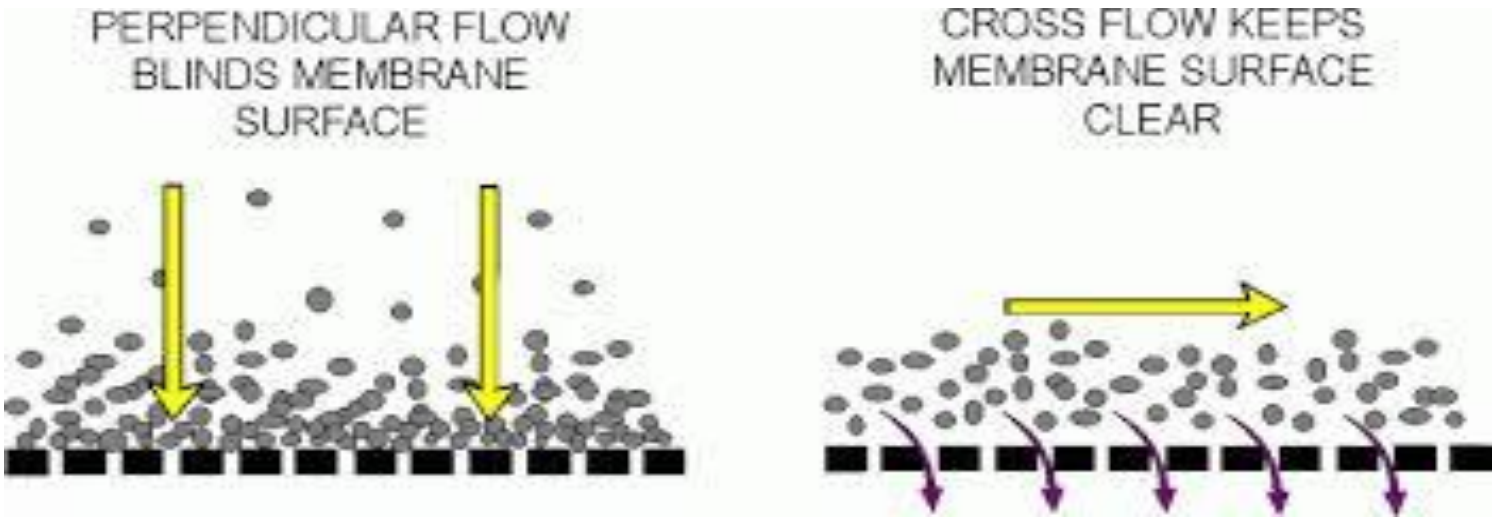
Crossflow membranes



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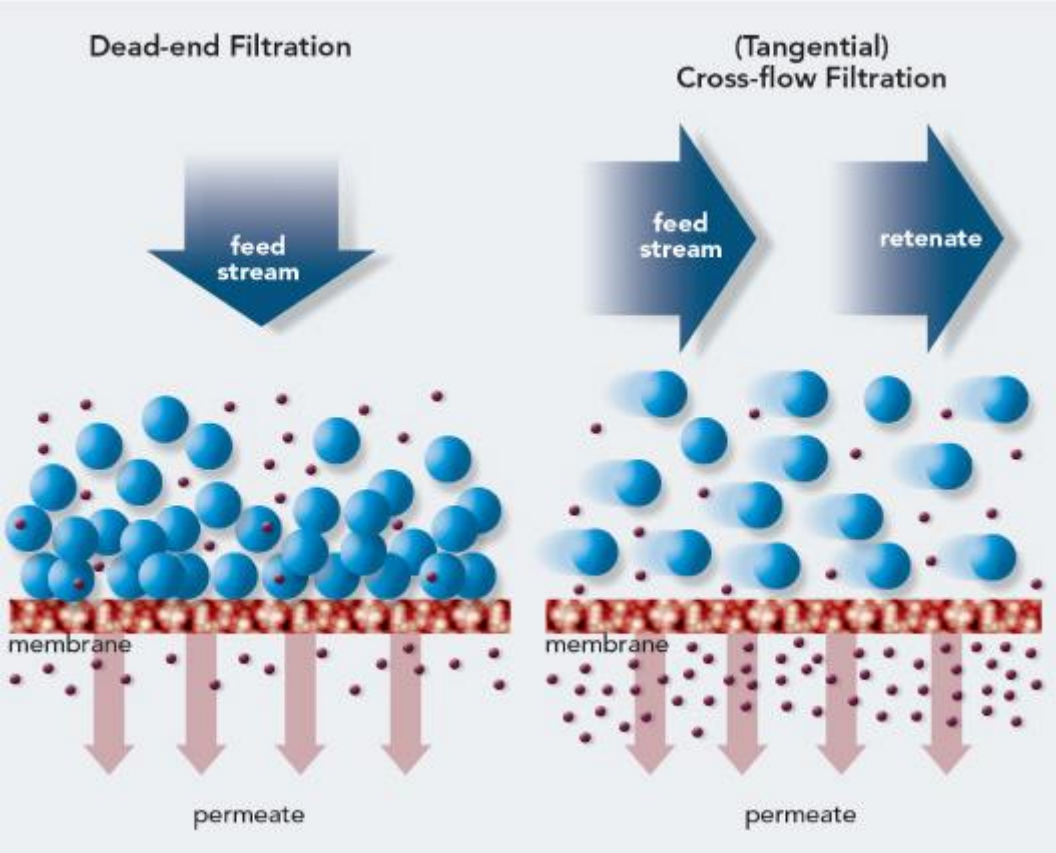
Crossflow vs Depth filtration



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Crossflow filter

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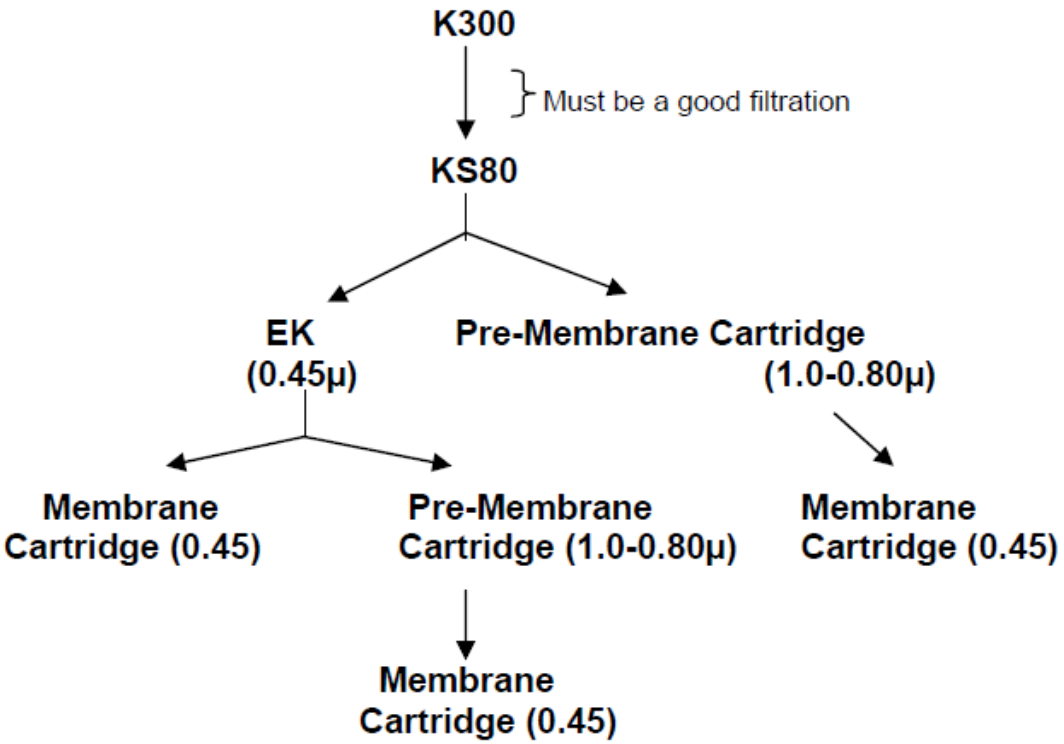
Sample Filtration Strategies

Most Common Routes for Pad Filtration in Whites:



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Record Keeping

- Maintain Notes
  - Date, Wine, Vintage
  - Where the wine is in process
    (i.e. after two rackings or stuck MLF)
  - Record filter type; capacity; grade; operator
  - Track original/terminal Differential Pressure (dP)
  - Periodically record:
    - Gallons filtered
    - dP for each filter stage

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Contacts

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