Wine Filtration
Filter Sheets & Lenticular Stacks

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Gusmer Wine – Technical Seminar

May 15-17, 2018

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Agenda

- Filtration Basics/Goals
- Depth Filtration Mechanisms
- Filter Sheets
- Lenticular Stacks
- Key Operating Parameters

Goals of Filtration

- Solids Reduction
- Visual Clarity
- Microbial Stability
- Sterile Packaging

- PARTICLE REMOVAL

Is Filtration the Only Way?

- Other Ways to Remove Particles…
  - Racking (Gravity)
  - Fining Agents + Racking (Gravity)
  - Decanters/Centrifuge (Centrifugal Force)

A typical winery uses multiple methods to remove particles

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What type of particles?

- **Rigid Particles**
  - DE/Fibers
  - Tartrate Crystals
  - Sand/Grit
  - Fining Agents (carbon, bentonite, etc.)
  - Oak Alternatives
- **Soft Particles**
  - Colloidal Proteins
  - Colloidal Phenolics
  - Lipids
  - Polysaccharides
  - Yeast/Bacteria
  - Grape Solids
  - Fining Agents (gelatin, isinglass, etc.)
- Insoluble particles – most fluids have both types

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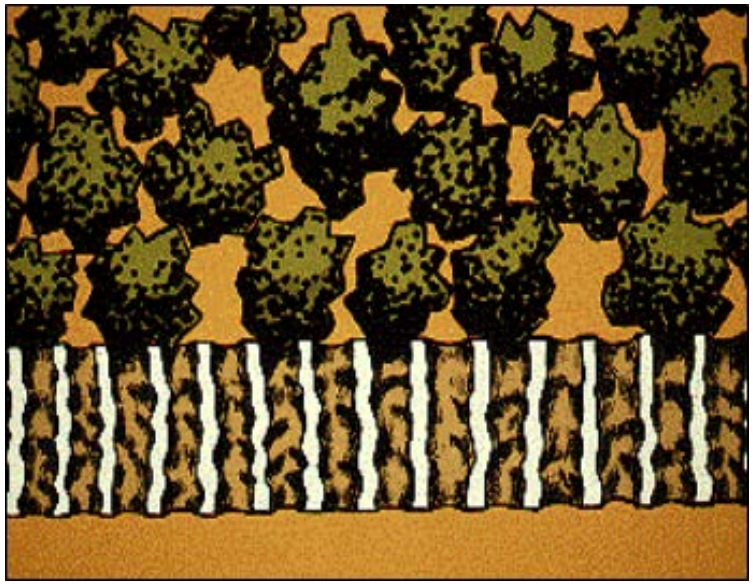
How do they behave?

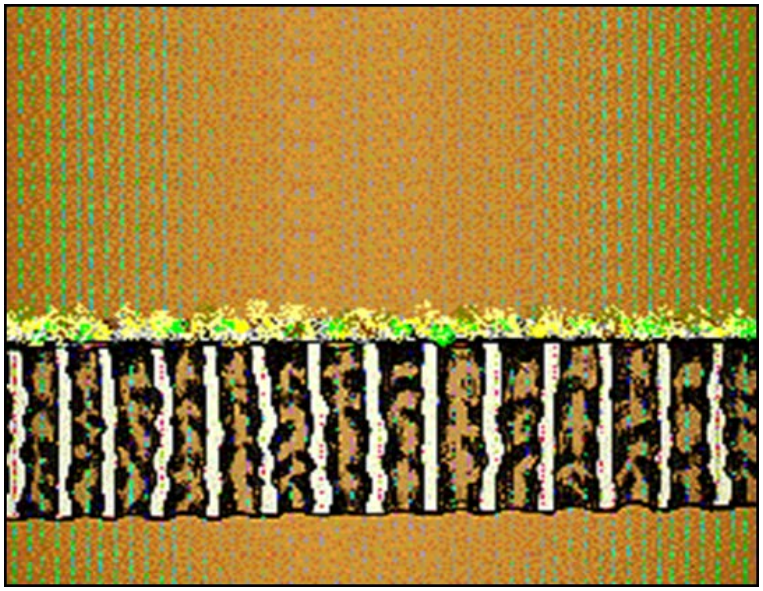
Rigid Particles

Accumulate, leaving channels



Soft Particles

Often flatten our or stick together creating a blocking layer



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What's in Your Soup?

- Wine can be considered a "soup" of deformable and rigid particles that range from <0.2 microns to 100 microns
- Goal: High solids + high turbidity → low solids + brilliant clarity

Difficult to filter in one easy step with conventional technology!

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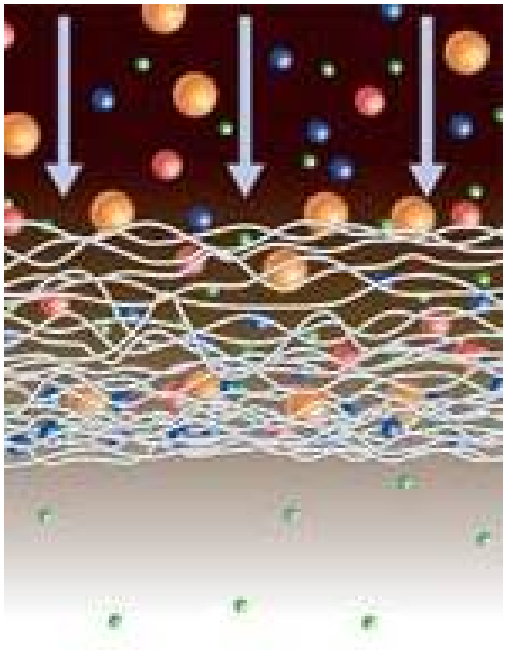
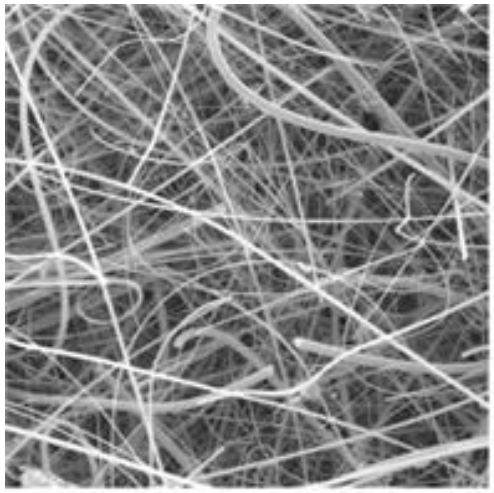
Depth Filtration

A thick layer of filter media where filtration occurs on the surface AND interior of the matrix.

- Advantage – High particle holding capacity
- Disadvantage – Nominal micron rating





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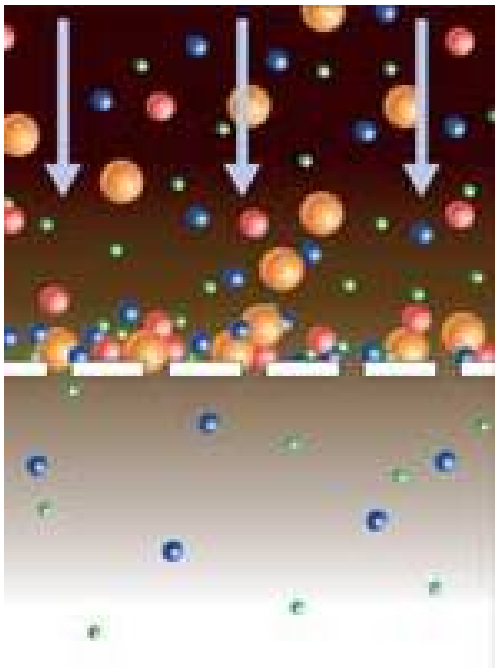
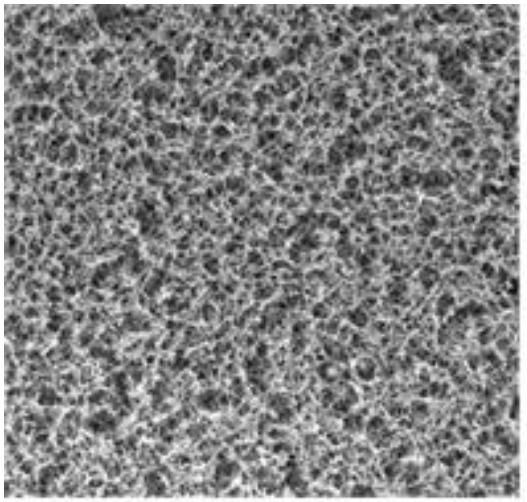
Surface Filtration

Thin layer of filter media where filtration occurs at the surface

- Advantage – Absolute micron rating
- Disadvantage – Low particle holding capacity





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Achieving Economical Sterile Filtration

- Best Solution

Depth (high particle loading capacity)

+ Surface (absolute rating/efficient)

Economical Sterile Filtration

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Sequential Filtration

Winemaking Process

Fermenting Wine
One Million Cells/mL + Grape Solids
5% solids, 200 NTU Turbidity

↓

Gross Solids Reduction
Getting wine off solids (reduce chance of H2S forming)
1M cells/mL to ~500,000cells/mL

↓

Blending, Fining, Stabilizing
Initial Clarification
~500,000cells/mL to ~50k cells/mL

↓

Prepare for Bottling
Sterile Prep
~50k cells/mL to ~9-10cells/mL

↓

Bottling
< 1 cell/ml

Filtration Steps

Lees Filtration
Recessed plate or rotary drum vacuum filters

↓

Rough Filtration
Course Filter Grade (CSF-SC)
Still cloudy but solids reduced (~50NTU)

↓

Polished Filtration
Polish Filter Grade (CSF-SP)
Starting to see some clarity (~5NTU)

↓

Pre-Membrane Filtration
Pre-membrane Filter Grade (CSF-UF)
Brilliant clarity starting to be seen (~0.5-1NTU)

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Sterile Filtration
Brilliant, sterile wine (~ 0.5 NTU)

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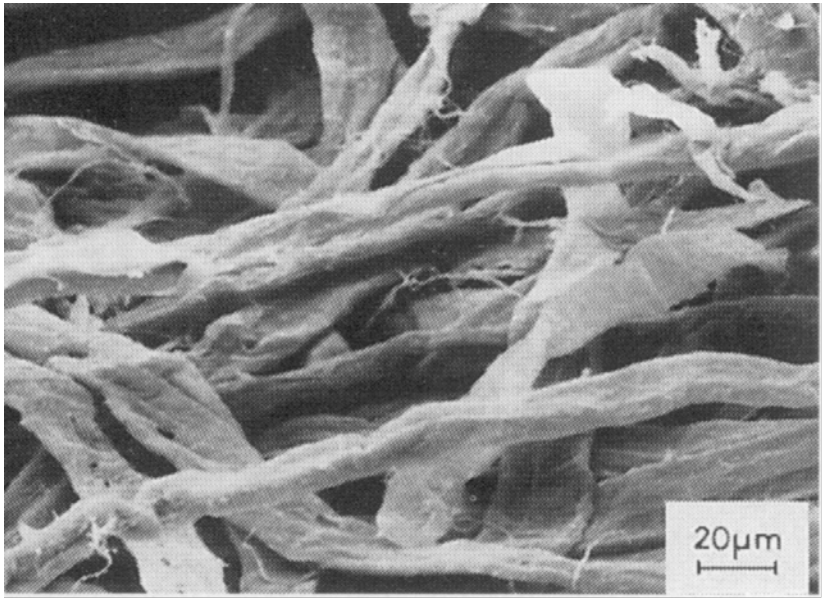
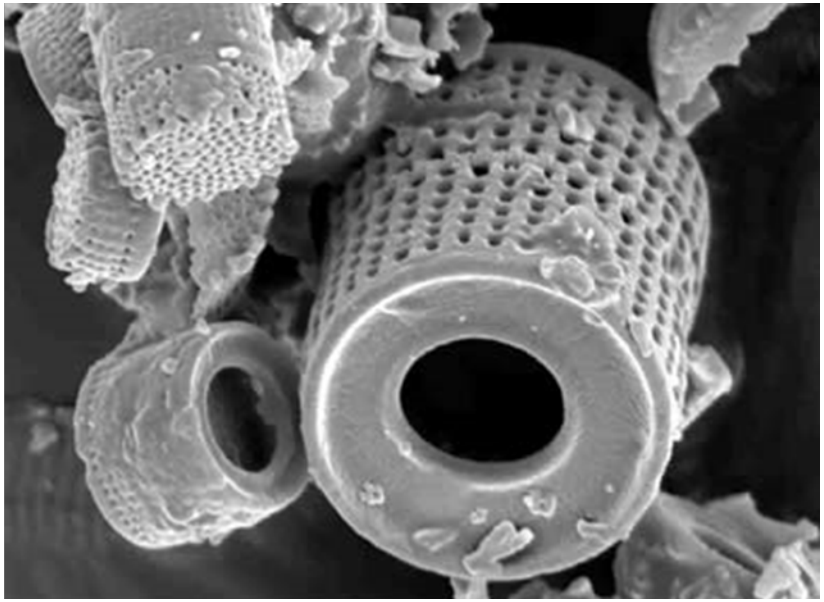
Depth Filter Media





Cellulose Fibers Diatomaceous Earth(DE)

+ Resin (Binder)

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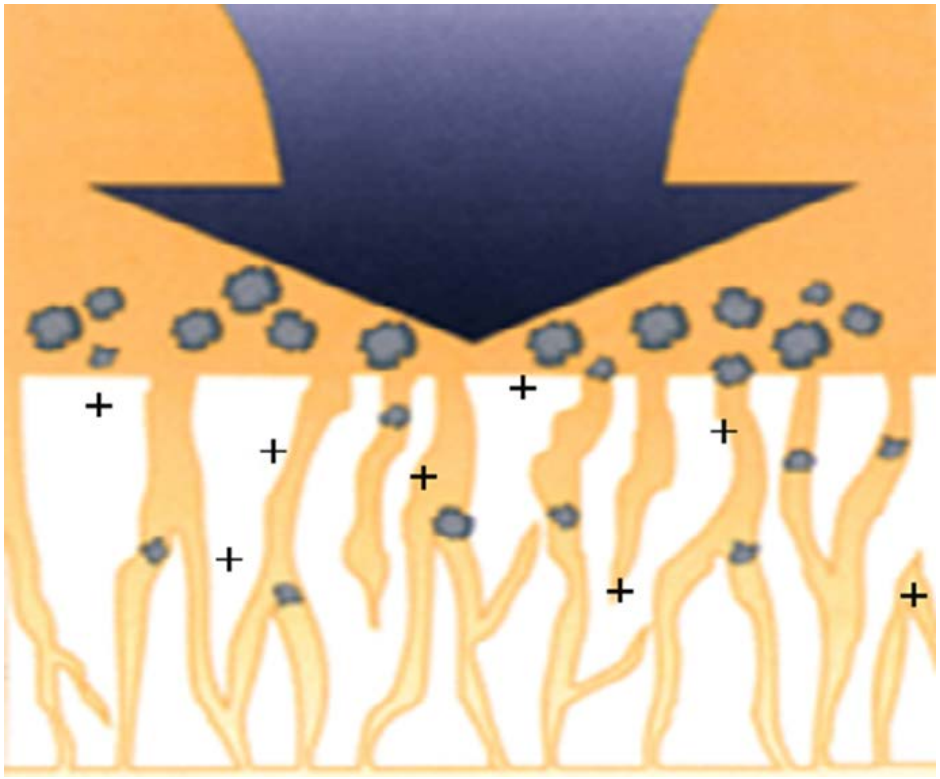
Filtration Mechanisms



Gradient Density Matrix

1. Some particles are too big to enter the filter, remain trapped on the surface (Sieving)
2. Some particles enter the filters pores and become trapped in the tortuous matrix (Entrapment)
3. If charged, some particles are attracted to the charge and become trapped (Adsorption)

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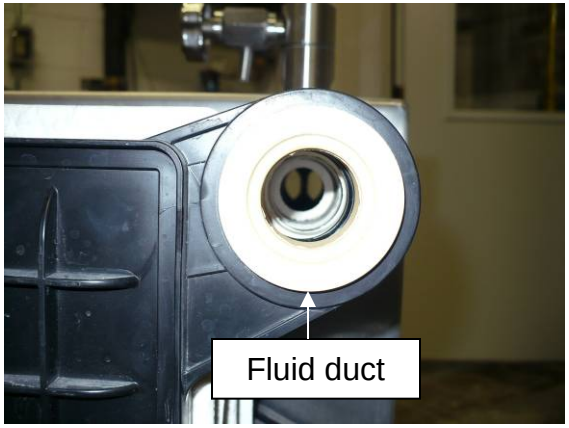
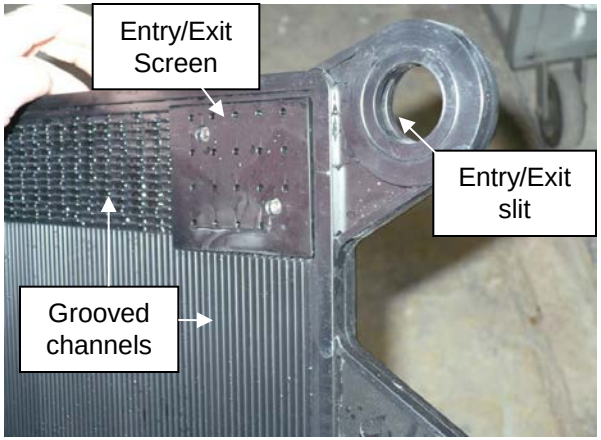
Plate Filter Press





Advantages:

- Consistent performance
- Lower cost (than stacks)
- Less waste (than stacks)

Disadvantages:

- some leakage (catch & return)
- longer set-up time (than stacks)

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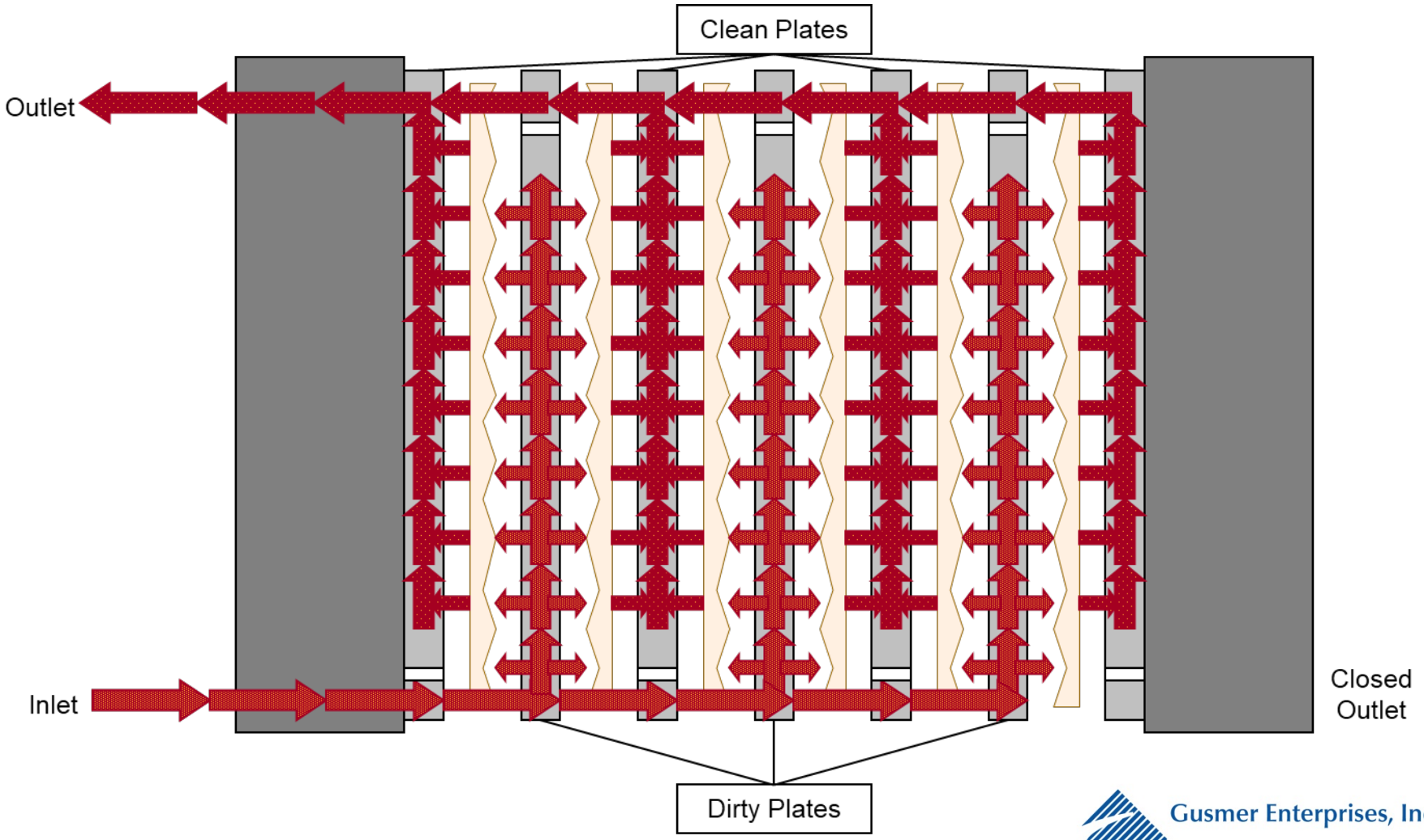
Filtration Flow Diagram – Top View



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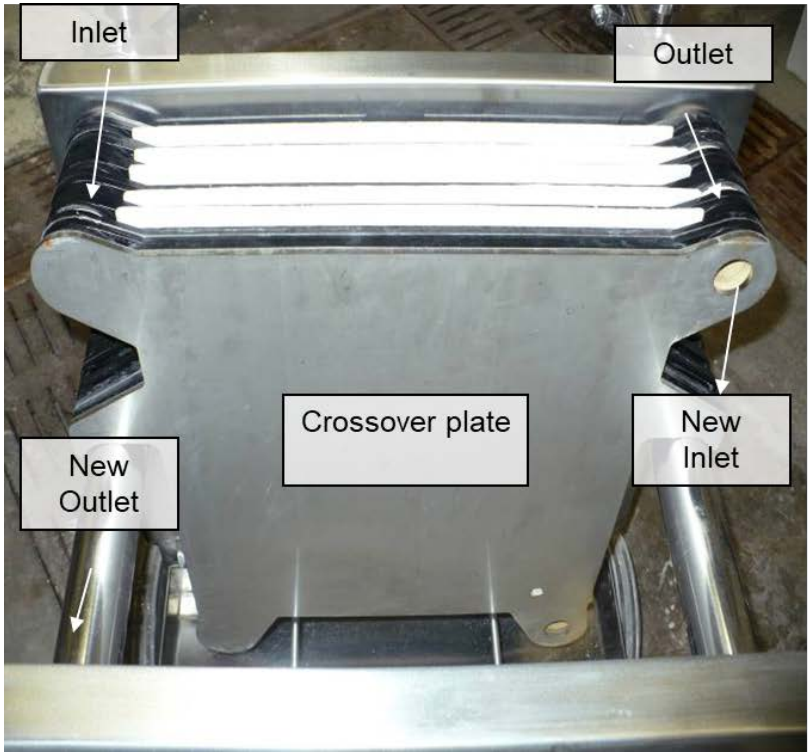
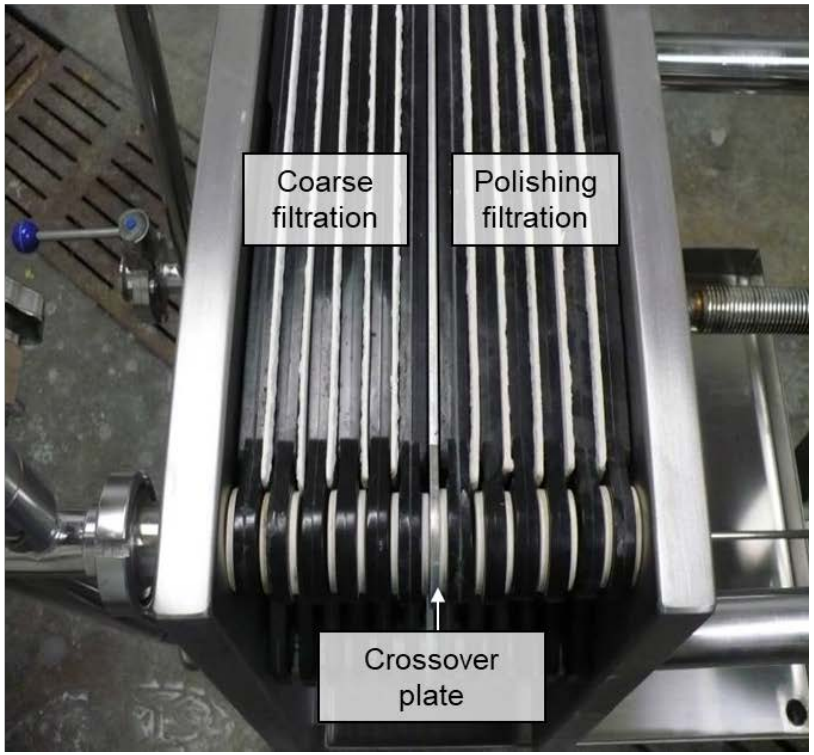
Multi-Step Filtration

Two filtration steps can be completed in the same filter press by placing a crossover plate between filter grades





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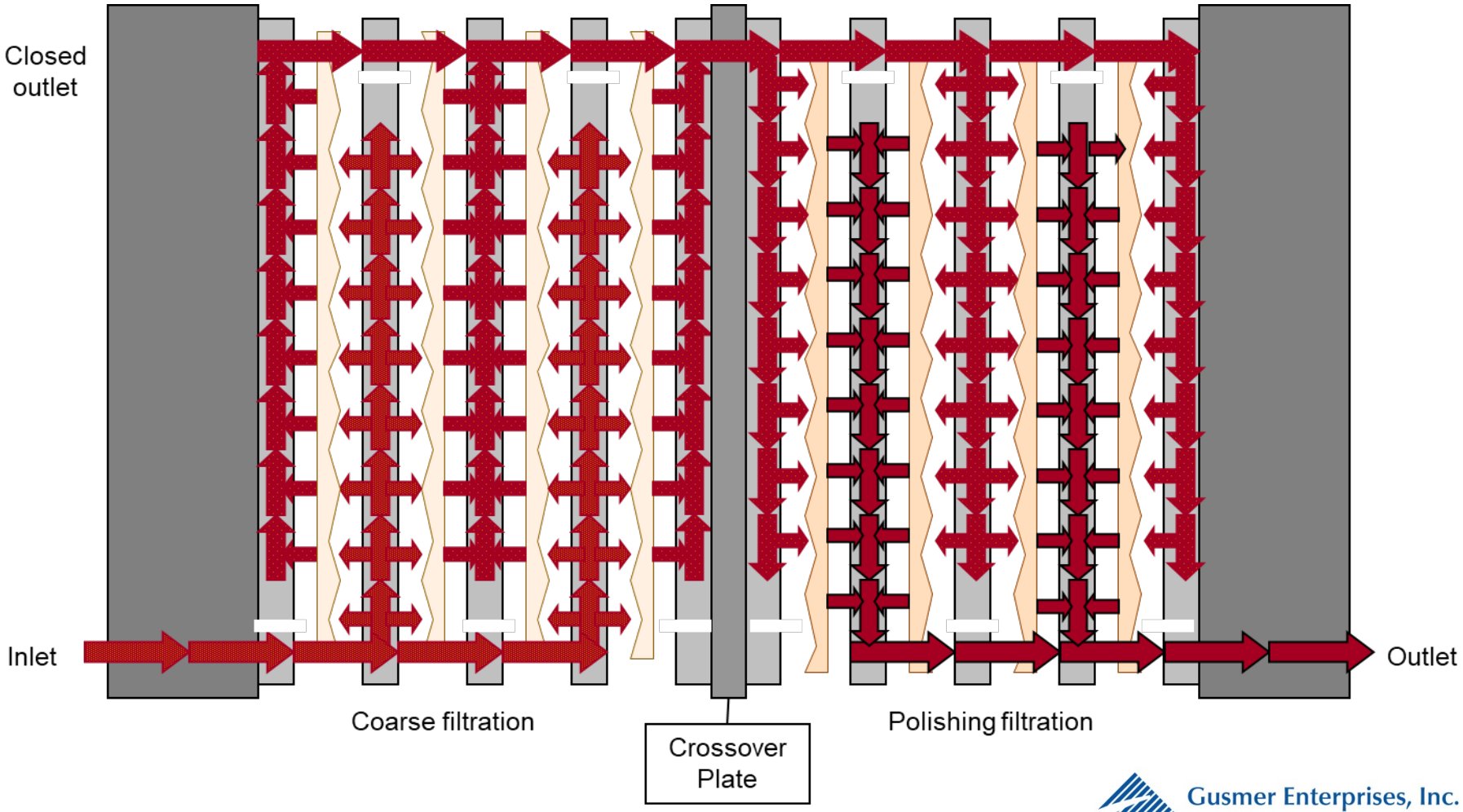
Multi-Step Filtration Flow Diagram – Top View



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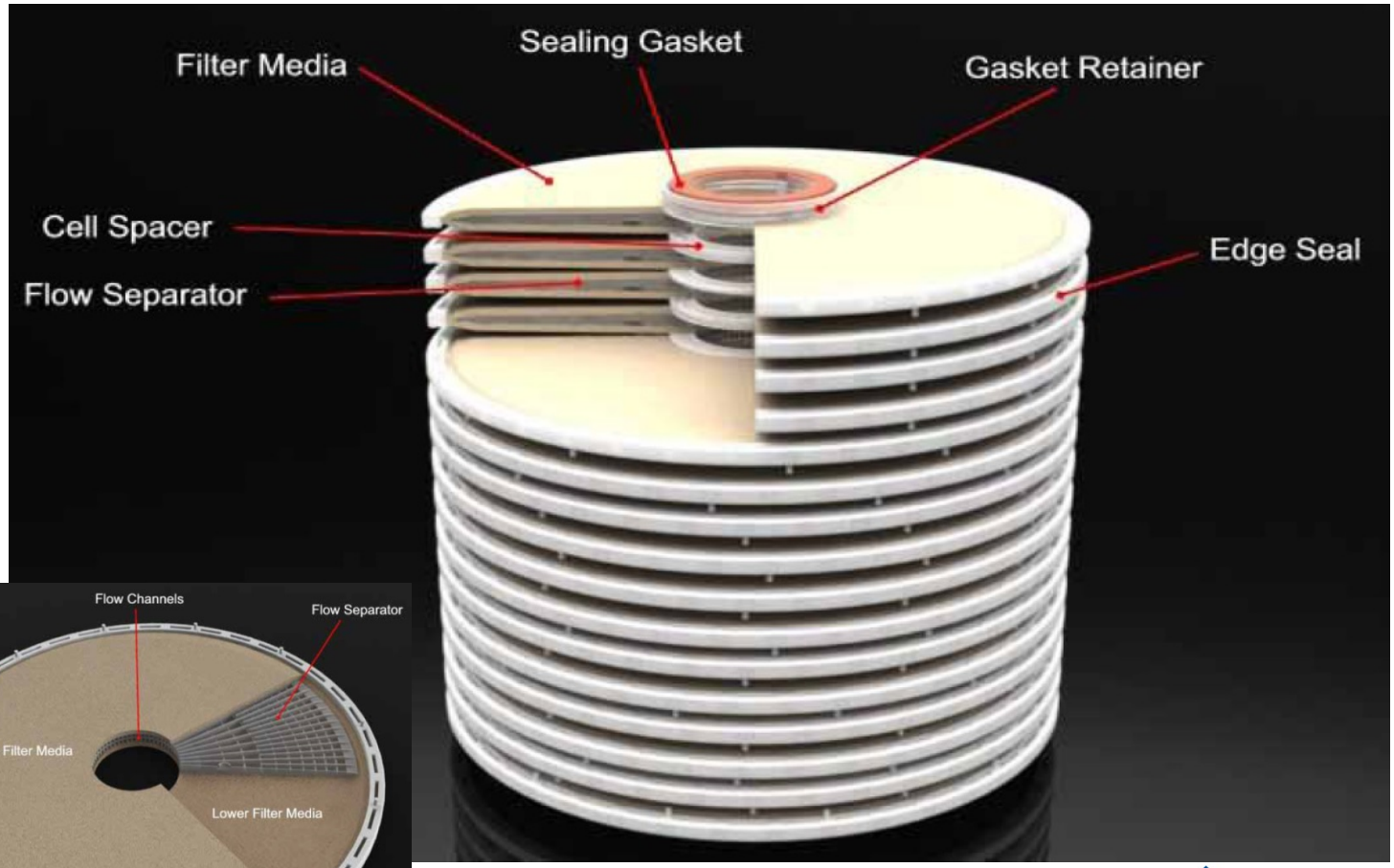
Lenticular Cartridge Filters

- Filter sheet media pre-assembled into a “stack” for fully enclosed filtration



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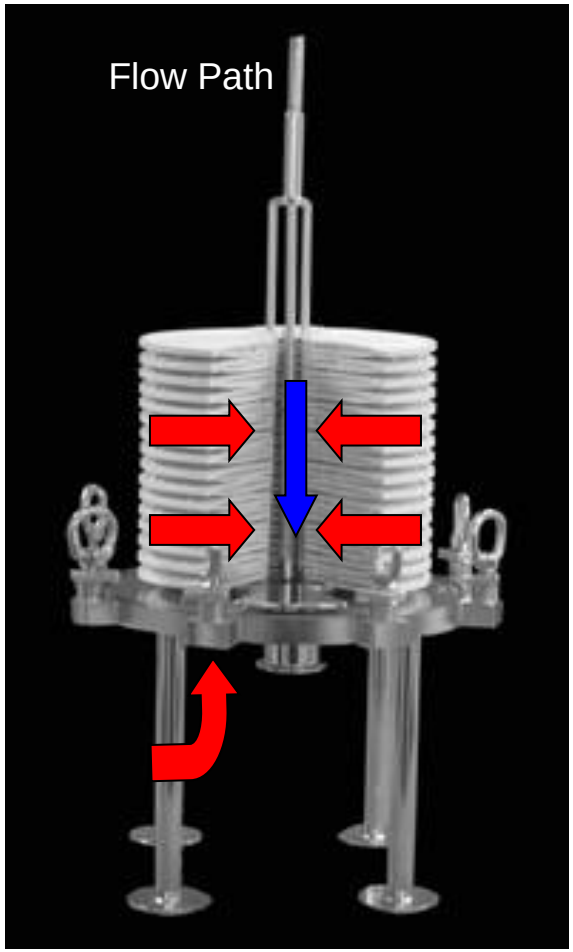
Lenticular Cartridge Filters



Advantages:

- Consistent performance
- Leak Free/Low loss
- Limited air exposure
- Quick set-up/Easy use

Disadvantages:

- More expensive (than sheets)
- Sensitive to backflow (easily avoided with check valve)
- More waste disposal

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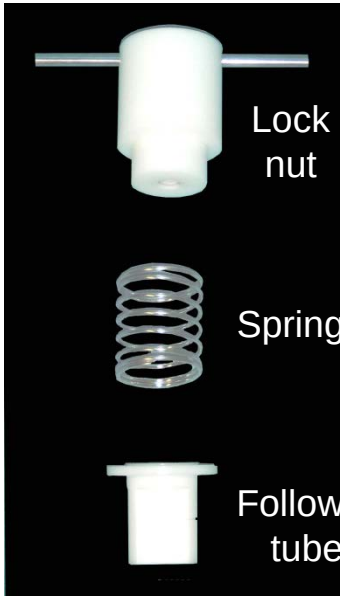
Lenticular Cartridge Filters

- ***Quick & Easy Set-up:***
- Place stacks on center post. If using less than housing's normal # of stacks, add a stack adapter
- Hand tighten lock nut assembly
- Replace & tighten housing dome



Pro & Con - Lenticular vs. Sheets

- Lenticular Cartridge
  - Full range of filter media
  - Easy to load
  - Small footprint
  - **No Dripping**
  - **Sealed (more sanitary)**
  - **More expensive per square foot of filter media**
  - **Low holdup volume**
- Filter Sheet
  - Full range of filter media
  - Takes more time to load
  - Larger footprint
  - **Drips**
  - **Exposed edges of filter media (less sanitary)**
  - **Less expensive per square foot of filter media**

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Important Filtration Parameters

Flow Rate

- Speed limits
- Filter grade (↓ pore size = ↓ flow rate)
- Surface area (gpm/**ft²**, ↑ ft^2 = ↑ gpm)

Differential Pressure

- Differential = inlet – outlet
- Pressure increases exponentially near termination

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Application / Flow Rates / ΔP

Application Guide				
Application	**Filter Grades**	**Recommended Flow Rates g/hr/sqft**	**Max. Flow Rates g/hr/sqft**	**Max. Diff. Pressure**
Coarse Filtration	**1925-1940**	**24 to 32**	**30 to 40**	**45**
Polish/Clarifying Filtration	**1945-1960**	**8 to 24**	**20 to 30**	**45**
Sterile Prep./Pre-Membrane Filtration	**1965-1975**	**3 to 12**	**10 to 15**	**21**

- Efficiency dependent on processing conditions *(flow rate, differential pressures, particle type, etc.)*
  - Lower flow rates allow for better retention
  - Lower differential pressures allow for better retention

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Filter Grades & Sizes

- **Grades**
  - Wide range of porosity and retention rates available
    - 0.3 to 20 microns (nominal retention)
- **Size**
  - Lenticular - 12 inch diameter (6, 9, 13 and 16 cells)
    - 1.11 square feet (effective area) / cell
      - ***16 cells… equals 17.7 square feet per filter***
  - Lenticular - 16 inch diameter (16 cells)
    - 2.375 square feet (effective area) / cell
      - ***16 cells… equals 38.0 square feet per filter***
  - Filter sheets - many sizes
    - have to consider edge loss when determining effective area (this varies from press to press)
      - assume a 1cm edge loss when determining effective area
      - ***40cm sheet… equals 1.5 square feet per filter***

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Basic System Sizing

- Determine the recommended flow rate for the application (i.e. polish filtration)
- Determine the desired GPM (i.e. 1,000 gph)
- Determine the square footage of media required to achieve the desired flow rate

Polish filter wine at a flow rate of 1,000 gph

Recommended flow rate = 16 g/h/sqft

Square feet required = 62.5 sqft

Number of Lenticular Cartridges = 3.5 (4)

Number of 40cm Filter Sheets = 41.6 (42)

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Why Slow Down?

Example: Wine was passed through a pre-membrane filter sheet at

5 or 15gal/hr/ft^2 flow rate

5 gal/hr/ft^2 = 0.54 NTU

FI 13

15 gal/hr/ft^2 = 0.72 NTU

FI 21

FI = Membrane Filterability Index (higher # indicates more difficult to sterile filter)

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Why Monitor Pressure?

1) **Efficiency**: Pressure above the recommended maximum can decrease filtration efficiency (just like high flow rates)

2) **Anticipation**: An increase in differential pressure indicates that the filter is beginning to plug & will need to be changed soon

3) **Optimization**: If pressure does not increase when filtering a product, it may indicate that a tighter (smaller pore) filter grade or less filter area could be used

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Golden Rules of Wine Filtration

1. Every wine filters differently.
2. Turbidity is not a good indicator of filterability.
3. Speed (high flow rate) is not your friend!
4. High pressure (Differential) is not your friend!
5. Depth filters are the work horse (take out bulk solids to protect the sterile membrane).

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Filter Press Troubleshooting

Symptom	Underlying Issue	Root Cause	Solution
Leakage	Poor seal at the gasket	Worn or cracked gaskets	Replace gaskets; use operator manual or contact the supplier to determine thickness
		Incorrect gasket size	Replace gaskets with gaskets that are the correct thickness (see above)
	Poor seal around the media	Insufficient filter press tightening	If unable to properly tighten the press by hand, a “cheater” bar or hydraulic closure can be used
		Misaligned sheets	Take your time and carefully align each sheet while dressing the press to ensure proper sealing
		Missing guide rods	Short-term: carefully hold sheets while tightening press Long-term: purchase replacement rods
	Incorrect operating parameters	High pressure or excessive flow rate	Follow filter sheet product literature for proper operating conditions of grade in use
Unexpected short life	Filter sheets placed backwards	Gradient density in opposite direction	Always face the cockled side of the sheet towards the plate with an un-gasketed inlet port
	Incorrect operating parameters	High pressure or excessive flow rate	Follow filter sheet product literature for proper operating conditions of grade in use
Unexpected breakthrough	Incorrect operating parameters	High pressure or excessive flow rate	Follow filter sheet product literature for proper operating conditions of grade in use

FOR REFERENCE

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Lenticular Filter Troubleshooting

Symptom	Underlying Issue	Root Cause	Solution
Unexpected breakthrough	Stack filter has ruptured	Unintended back-pressure (most common cause)	Always install a quick acting check valve at the exit of the housing
		Improper storage (rare)	Never remove wet stacks from housing for storage, if needed, store in closed housing
	Fluid is bypassing the media	Missing stack gasket (most common cause)	Always check each stack to ensure it has its end gaskets while installing
		Center post not properly sealed (rare)	Follow literature instructions to hand tighten the follower assembly, this is sufficient for a proper seal
	Incorrect operating parameters	High pressure or excessive flow rate	Follow filter sheet product literature for proper operating conditions of grade in use
Leakage at base of the housing	Housing is not properly sealed	Torn or misaligned o-ring at housing base (most common cause)	Always inspect the o-ring before use and replace if damaged. Make sure o-ring is properly seated in its grove and housing bolts are snug
		Housing base bolts are not properly tightened (rare)	Follow housing literature instructions to hand tighten the base bolts, a wrench or “cheater” bar can also be used if necessary depending on the housing model

FOR REFERENCE

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Questions?

Thank You

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