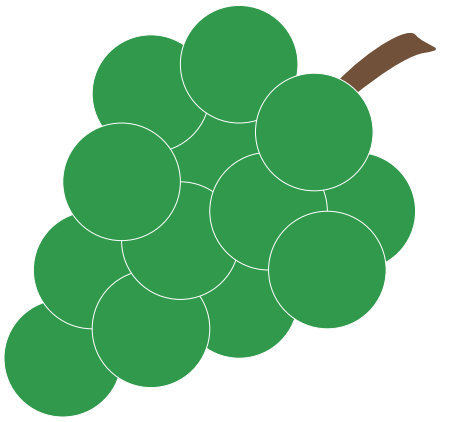
Fermentation to Filtration



By David Akin, Salvatore Napodano and Kamla Jevons

Winemakers and connoisseurs alike can benefit from new technology

Treatment and product recovery from wine lees, the sludge-like sediment left behind when wine or juice is transferred from one tank to another, is one of the biggest challenges facing the wine industry. The desire to minimize winery waste volume coupled with legislation that limits the disposal of unwanted byproducts has made the lees issue even more important to producers.

Koch Membrane Systems (KMS) crossflow membrane filtration technology has led to a new method for recovering valuable wine and juice from lees. This process entirely eliminates the need for diatomaceous earth (DE) and other filter aids currently used with traditional recovery techniques. Crossflow microfiltration membranes configured in a multi-tube modular geometry are ideal for clarifying lees, and the tubular design is well suited for processing streams that contain high levels of suspended solids such as juice and wine lees.

Wine Quality

Wineries using crossflow membrane filtration systems are recovering wine of higher quality and therefore higher value when compared to traditional systems. Higher value wine plus significant annual operating cost savings are providing wineries with an attractive return on their investment.

During the winemaking process, insoluble solids are generated, which have to be removed before bottling. These solids include fine fruit particles, tartrate salts, spent yeast, bacteria and soil and debris carried over with the fruit. Also, fining agents are frequently added to the wine and contribute to the volume of settled solids. Fining agents may include bentonite, gelatin, silicasol, albumin, activated carbon and polyvinylpolypyrrolidone.

All of these solids eventually settle by gravity into a sludge-like material that is generically called lees.

Wine producers generally classify lees into two categories: “sweet lees,”

Figure 1. Typical Membrane Processes for Wine, Lees and Must Filtration

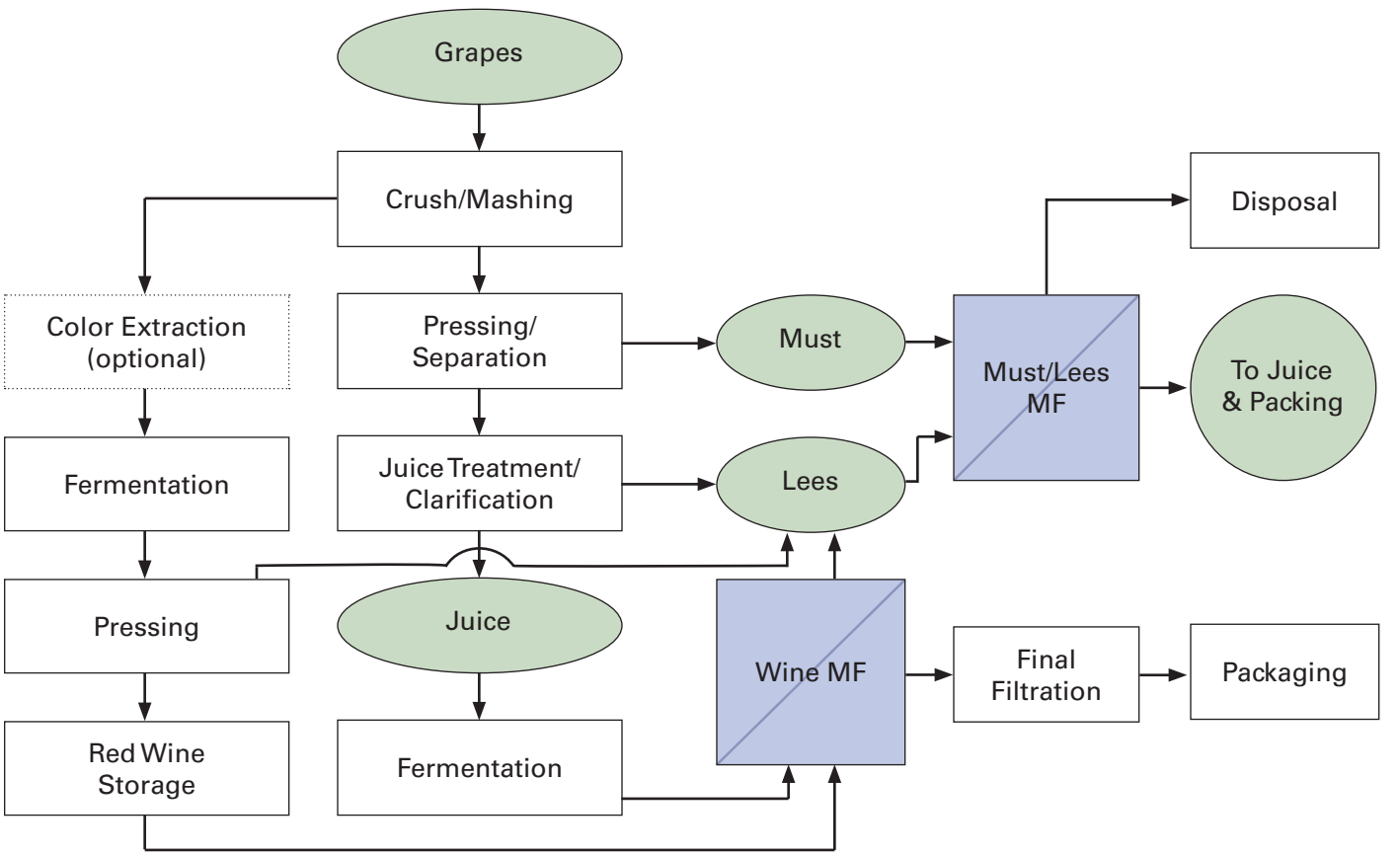


Figure 2. Membrane filtration in wine production is most commonly used to remove suspended solids and turbidity while allowing the passage of color, ethanol, flavor and aroma components.

also commonly called "must lees," and "fermented lees," also known as "wine clarifier lees." Sweet lees are the settled solids typically found in white grape juice and often are further processed to gain higher yields, while fermentation lees consist of all sediment remaining after fermentation and fining. On average, about 10% of the initial volume is removed as lees, which still contain a high percentage of recoverable juice or wine.

Wine recovered from lees using traditional techniques—rotary vacuum or plate filters—often is of low quality and may require further processing before being blended into a usable product. Lees are often accumulated from several batches of wine before being clarified in order to maximize the efficiency of traditional recovery. These older processes can result in oxidation of wine, yield loss and higher operating costs.

When using newer crossflow membrane filtration technology, producers can efficiently recover quality wine from the lees that is comparable to wine filtered on the main wine crossflow filtration system. The automated or manual crossflow membrane filtration equipment is simple to use, less labor intensive and increases yield while reducing byproduct disposal costs.

A Better Way

Most wineries employ some means to get the maximum recovery from juice "must." The typical methods of separation include rotary vacuum drum filters, centrifugation and plate and frame filters. The recovered juice is unfermented and is usually recombined with the racked juice without affecting the must quality.

Once the must is fermented into wine, microbiological activity ceases and sediment collects on the tank bottom. If there is sufficient time, a very clear wine will result with very compact lees. This is seldom the case, however, because wineries usually need

Table 1. Recovery of Wine from Lees Using Crossflow and Traditional DE

Volume of wine produced (3,500 tons/year)	710,000 gal	Recovered wine market value (DE/crossflow)	$2.00/$3.00
Volume of lees produced (at 10%)	71,200 gal	Value of recovered wine using DE at 75% recovery	$106,000
		Value of recovered wine using crossflow at 80% recovery	$170,880
Operating Costs:		Additional revenue with crossflow	$64,080
• Energy, labor, chemicals (DE)	$13,725	Total annual savings/revenue gain with crossflow	$96,667
• Energy, labor, chemicals (crossflow)	$9,238	Capital investment cost of crossflow filter	$106,000
• DE media cost	$30,000	**Payback analysis:** **Simple Payback: 13 months**	**IRR = 99.8%**
• Membrane replacement cost/yr (3-year life)	$1,900		**NPV 26% = $591,000**
Operating cost savings with crossflow	**$32,587**		

to use the tanks for other batches and the wine is typically racked prematurely, resulting in relatively low-solids lees that contain a significant amount of valuable wine. This wine is difficult to recover from the lees and is frequently discarded by small wineries. Larger wineries seeking to maximize yield normally use the same DE filtration devices that are used for must lees for further recovery.

In most cases, wines recovered using these filters are of inferior quality and can, at best, be used to blend into low-quality, low-priced wines. This is due to the long contact time with oxygen and the flavors imparted by DE, as well as some of the yeasty characteristics from fermentation. Much of this wine requires further processing and ends up as a base for products such as wine coolers and flavored wine products.

Key Benefits

Crossflow membrane technology uses highly-engineered, semi-permeable physical barriers that permit the passage of desired constituents based on size, shape or character. Membranes are available in a variety of configurations, materials and sizes. With crossflow membrane technology, a feed stream is introduced into the membrane module under pressure and flows over the membrane surface in a controlled operating mode. The selective barrier of the membrane separates the feed into a permeate and a retentate stream, both of which may be of value.

While used for numerous purposes in many industries, membrane filtration in wine production is most commonly used to remove suspended solids and turbidity while allowing the passage of color, ethanol, flavor and aroma components. Other membrane applications for wine and juice include sugar concentration in must, volatile acid and alcohol adjustment and color concentration and standardization.

Polymeric crossflow membranes, the type most often used in wine applications, vary depending upon the separation requirement and are provided in a number of different configurations including hollow fiber, spiral wound and tubular. Membrane porosity also varies with the application; the tightest

is reverse osmosis, through nanofiltration, then ultrafiltration and finally, the most open, microfiltration.

Crossflow membrane filtration, while relatively new, is an industry-accepted technology for wine filtration. However, until recently, the only method for wine and juice recovery from lees has been the use of traditional DE filtration techniques. Polymeric tubular membranes are often used for fluids with very high concentrations of particulate matter and, when constructed in a sanitary geometry, are ideal for lees processing. When crossflow membrane filtration for wine clarification and recovery of wine and juice from lees are used together in a winery, the result is higher quality wine and higher yields.

Figure 1 (page 12) shows an example of a typical crossflow microfiltration process for wine and lees filtration. All steps are low-pressure (10 to 100 psig) processes that retain the suspended solids and pass all dissolved material below an average pore size range of 0.3 microns.

Gaining Ground

The crossflow membrane filtration process for recovery of wine from lees has been used successfully by producers of both red and white wines and continues to escalate in its popularity. First and foremost, under normal circumstances, crossflow membrane filtration maintains the wine's important qualities, including acidity, aroma, color, flavor and clarity, with little or no oxygen pickup or temperature rise. Figure 2 (page 13) shows a photograph of a pilot KMS lees recovery system now in use at a large producer of red and white wines.

The economics of the membrane filtration system are favorable when compared to DE filtration. Table 1 illustrates the relative costs for crossflow membrane filtration versus traditional DE filtration of lees. Recovery of high-quality wine with the membrane-based lees filter gives an enhanced return on investment mainly because of the increased value of the wine recovered using crossflow membrane filtration.

In Conclusion

To sum it all up, lees filtration with crossflow membrane technology offers increased product yields, reduced costs and fewer problems with disposal of organic byproducts and waste. It offers lower operating and labor costs when using the automated or manual crossflow membrane filtration equipment, recovery of a product that is comparable to the original wine or juice quality, enhanced return on investment and elimination of filter aids that may pose health risks to the workforce during handling and use.

The finished characteristics of the wine are typically unaffected by the crossflow process, and the wine maintains its desirable characteristics. *wqp*

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