winemaking

# Product Review: Peristaltic Pumps

## The best pump no one uses

*Curtis Phillips*

**IT'S FUNNY HOW** different parts of the wine industry can have different idiosyncrasies regarding equipment, even equipment as humble as a pump. The Europeans use a fair number of progressive cavity pumps to move wine around, which is almost unheard of in the U.S. Our progressing cavity pumps tend to be restricted to moving grapes, must and lees. At the same time, it's almost unusual to find a decently-sized Californian winery that doesn't have either a red (Carlesen) or blue (Process Industries) **Waukesha.**

One pump design that I almost never see in U.S. wineries is the peristaltic pump. I've spent a fair amount of my career as a Pinot Noir winemaker, which has led me to spending a fair amount of time thinking about how to move wine as gently as possible. The consumer wine press (I mean the wine obfuscation industry) is quite content to pontificate that gravity is the only way to move delicate or finicky wines like Pinot Noir. Sure, fine, if one's a "gazillionaire" who can design a vertical winery and never use a pump, or a filter, again. The rest of us still need to pump wine around.

I suppose that nitrogen gas pressure could be used, but this has some of the same problems as gravity-flow. An existing facility most likely has to be redesigned in order to use it. There are a couple of further, albeit not insurmountable, obstacles to using nitrogen to push one's wine around. Wine can be moved around with fairly small increases in nitrogen pressure, but having to fill every tank one wants to empty with more than one volume of nitrogen is going to get expensive fast. Some sort of pressure vessel, like a Charmat tank, is needed so that wine can be put under enough pressure to force it through filters, fillers and such. Finally, the winery has to be well ventilated since the entire winery is essentially turned into a positive-pressure bottling tank.

Now, to be fair, I have to state up front that I like peristaltic pumps. That said, it's the basic design that interests me. I'm not an advocate of any particular peristaltic pump manufacturer.

### WHAT ARE PERISTALTIC PUMPS?

Peristaltic pumps work on the "squeeze-the-tube" principle most of us use every morning. Outside the wine industry, the peristaltic pump design is used to transfer extremely fragile fluids like blood or viscous or abrasive liquids and slurries that would damage most other pumps (see sidebar).

Within the wine industry, peristaltic pumps are marketed as being able to replace any other type of positive displacement pump (i.e., any progressive cavity, lobe or piston pump) in essentially any winery operation. Since the mechanical parts of the pump never touch the must/wine/lees, peristaltic pumps are resistant to abrasives like bentonite: an apparent advantage they have over progressive cavity and lobe pumps. They can also run dry, unlike flexible impeller pumps, and offer capacities of up to 20,000 gallons per hour.

### PERISTALTIC PERCEPTIONS

Admittedly, mainly due to my own interest, peristaltic pumps have been an occasional topic of discussion when I've talked with other winemakers over the past three decades. Winemakers' criticisms of peristaltic pumps seem to fall into two categories: (1) cost or (2) durability.

The cost argument is, I think, the least persuasive. Up front, peristaltic pumps don't cost much more than do the ubiquitous Waukesha rotary lobe pumps.

The relative cost of maintaining the two types of pumps leads us into the question of relative reliability, durability and maintenance. Again, in my opinion, under normal circumstances there's little difference in the relative reliability and maintenance. In my experience, both breeds of beasties need a minimal amount of daily care and feeding to keep them running reliably with the main difference being that the U-tube(s), and maybe the rollers, in a peristaltic pump will need to be replaced fairly regularly. I like to replace the tubes before crush every year, and the rollers only if I notice that

### Defining Some Winery Pump Terms

**Positive Displacement Pump:** A positive displacement pump is any pump where the liquid is moved through the pump in discrete cavities. Except for centrifugal pumps, essentially all winery pumps are some type of positive displacement pump. In the U.S. wine industry, the term is often used synonymously for rotary lobe pumps. While rotary-lobe pumps are indeed a particular type of positive displacement pump, so is every other pump in the winery except centrifugal pumps.

**Peristaltic Pump:** Peristalsis is the progressive constriction and relaxation of a tube, or canal, so that the resulting wave-like motion moves the contents of the tube forward much in the way toothpaste is squeezed out of a tube. A peristaltic pump achieves this by using rotor inside a semi-circular loop of flexible tubing to squeeze the tube. As the a rotor turns, the "pinch" moves around the loop and displaces the fluid through the pump. Since the fluid is displaced by the contraction of the tube, it doesn't experience shear or cavitation.

**Progressive Cavity Pump:** A progressive, or *progressing*, cavity pump has a helical rotor inside of a helical cavity. As the rotor turns, a void, specifically in the shape of a helical annulus, moves along the cavity thus displacing the wine forward.

**Rotary Lobe Pump:** Rotary pumps displace liquid by means of two intermeshed lobed rotors. The typical rotary lobe pump in the U.S. wine industry is the Waukeshau.

they're beginning to wear or crack. I tend to keep a few sets of the old tubes and rollers so that I have a small stockpile of spares to tide me over if there's ever a delay in getting my annual replacements.

As to durability, a peristaltic, especially a big one used for pumping must, will pass far more junk without damage than either a rotary lobe or a progressing cavity pump. It doesn't take too many ingested vineyard staples, trellis cross-arms or hose clamps for the maintenance and repair costs of either a rotary lobe or a progressing cavity pump to far outstrip the cost of annually replacing the tubes and rollers on a peristaltic pump.

## VERSATILITY

As I noted in my discussion about flexible-impeller pumps, small wineries tend to start out with a flexible impeller pump rather than with another type of pump. Flexible impeller pumps are correctly viewed as being one of the more versatile options available. However, flexible impeller pumps are not without their drawbacks. They are easily damaged if run "dry" since the design uses whatever fluid is being pumped to cool the impeller, and they are usually more easily clogged than other positive-displacement pumps of similar size. The impeller is also easily damaged, but this can be viewed as both an asset and a detriment of the flexible impeller design.

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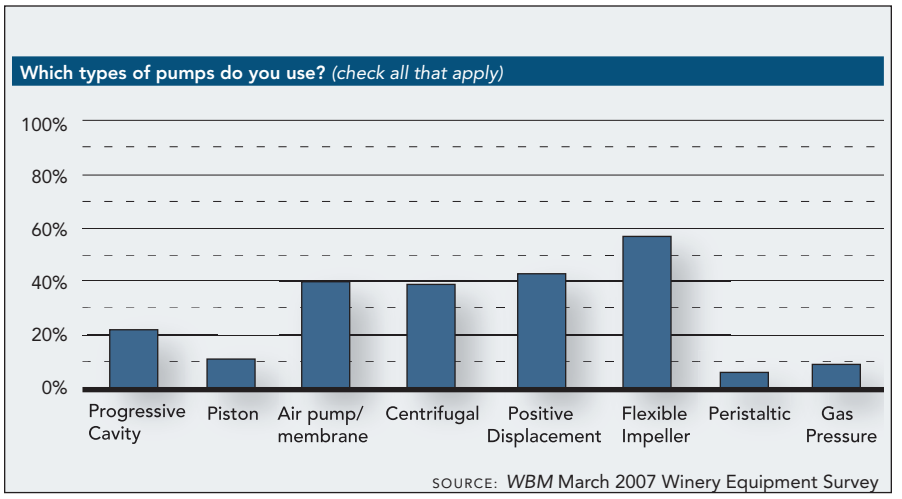
## SUITABILITY FOR DIFFERENT TASKS

I would suggest that the peristaltic pump design is at least as versatile a pump for the modern winery. In particular, the design can pump any liquid and just about any semi-solid that will physically fit into the inlet. This includes wine and juice of course, as well as must and destemmed berries, but also pomace (marc) and whole clusters. Although in this last example, I'd expect significant numbers of berries to get knocked off their rachis in the process simply due to the "straight-pipe" friction of being pumped through a hose.

At the risk of being overly simplistic, I'd like to note the various wine production steps where a pump can be used and then place these operations into a few different categories. Due to the constraints of space, I'll have to keep things pretty simple. Before anyone starts objecting that they *never* would use a pump for any particular grape, juice, must, wine or pomace movements, please note that the operations listed are examples of where a pump might be used, not necessarily where I believe they ought to be used under all circumstances.




To start more or less at the beginning for white wines, we have the movement of the white grapes from the destemmer to the press; the movement of the resulting white juice from the press sump to the fermenter; the movement of resulting wine from tank to tank for settling, blending and stabilization; filtration; and finally bottling.

Red wine production obviously has a different order and more operations, with pump-overs and élevage being the most obvious differences. First, red grapes are pumped from the destemmer to the fermenter. Next, the red must can be pumped over during fermentation. After fermentation, the must is pumped from the fermenter to the press and pressed. The resulting wine is then pumped from the press sump to a setting or holding tank where it may be inoculated for malolactic fermentation. If the wine is to be barrel-aged, it is then pumped to barrels for élevage. After élevage, the wine is pumped out of barrels to blending tanks. Red wine may then be stabilized, filtered and bottled.

### Pumping Must from Destemmer to Fermenter or Press

Must pumps, the pumps that move the grapes and juice from the destemmer to the fermenter, are almost always some form of large positive displacement pumps. The peristaltic design fulfills the requirements for an ideal must pump insofar as it can move the destemmed berries from the destemmer to the tank or press without macerating them or their seeds.

### Press Sump

Once white grapes or red grapes are in the press, a pump is needed to move the juice or wine from the press sump to a tank. The main requirements for this task are the ability to empty the sump quickly. The ability to connect and use a float controller is desirable since this reduces the workload on the press operator; but if this isn't possible, then it's imperative to get a pump that won't be damaged by short periods of running dry. I wouldn't even bring it up if it wasn't an attribute of the peristaltic pump design.

For white juice, I prefer appropriately-sized peristaltic pumps that can pump quickly and gently as this minimizes emulsion of the solids in the free-run.

### Pumping Over

Peristaltic pumps are able to pass significant amounts of suspended solids, in the form of grape pulp, skins and seeds without grinding or breaking any seeds, and, ideally, without overly macerating the skins and thereby increasing turbidity.

### Pumping Wine, Pomace from (Red) Fermenter to Press

If the peristaltic pump has been fitted with a feed-hopper, it can be used to move wine and pomace from the fermenter to the press. Again, the design of a peristaltic pump means that the pomace isn't subjected to shearing forces as it moves through the pump. As with any movement through a hose, however, there's still a bit of "straight-pipe" friction.

### Moving Marc, Pumping Pomace

Pressed grape skins and seeds are called pomace or marc. In the U.S. wine industry, these terms are used interchangeably, but for the sake of this discussion I'd like to have different terms for the post-fermentation grape solids before and after they are pressed. To this end, I'll define pomace as what's

**Pump Applications and Ratings**

| Pump Type | Must | Pomace * | Pumpover | Transfer | BBL Fill | BBL Empty | Filtration | Bottling | Price | Durability | Repair Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Centrifugal | | | | ••• | | | | | $ | ••• | $ |
| Elliptical Lobe | ••• | •• | | | | | | | $ | •• | $$ |
| Flexible Impeller | • | | •• | • | ••• | ••• | •• | ••• | $ | • | $ |
| Progressive Cavity | ••• | • | | • | | | | | $$$ | •• | $$$$ |
| Rotary Lobe | •• | • | ••• | •• | •• | • | ••• | ••• | $$$ | ••• | $$$$ |
| Rotary Piston | ••• | • | ••• | •• | ••• | ••• | •• | •• | $$$ | ••• | $$$ |
| Diaphragm | | | | ••• | ••• | •• | | | $$ | •• | $$ |
| Peristaltic | ••• | ••• | •• | ••• | ••• | ••• | • | • | $$$$ | ••• | $$ |
| Reciprocating Piston | •• | | | • | | | •• | •• | $$ | ••• | $$$ |
| Inert Gas "pump" | | | | | | ••• | | | $ | •••• | $ |

* It is usually best to move pomace using bins, belts or augers rather than by using pumps.

left in the fermenter after it has been drained and marc as what's left in the press after pressing. In this usage, it's the same stuff, grape skins and seeds, but marc has quite a bit less moisture in it than pomace.

Neither pomace nor marc are pumped in most U.S. wineries. Most small wineries simply shovel or pump it into macro bins and move the bins using forklifts and pallet-jacks. Larger facilities typically use augers and/or belts to move the marc away from the press for disposal. In Europe, a couple pump types, including peristaltic pumps, can be found being used to take marc away from the press even in smaller wineries.

As I see it, the main problem with using a peristaltic pump to move marc after pressing is that frequently that is exactly the time the peristaltic pump would be needed to move wine and pomace from the fermenter to the press or presses. Of course, since a press isn't going to be filled before it has been emptied, the peristaltic could do double duty by dragging it back and forth provided only one press is being filled and emptied. With multiple presses, I think it makes more sense to dedicate equipment to each task so that one isn't standing around waiting for a pump.

In that case, one could get more than one peristaltic and simply use it to empty presses; but to be honest, I'm not sure I would invest in a peristaltic pump just to move marc. After all, unless one is making grappa, the marc is just going to a compost pile. At this point we don't really care if the seeds and stems are ground up. I would be tempted to dedicate a cheaper elliptical-rotor pump to this job.

### Moving Wine

Wine movements, that is moving wine or juice from tank to tank, can be thought of as the most basic pumping operation in wine production. It's somewhat appropriate then that one can get by with the most basic pump.

### Bentonite

Kaolin clay, also know as Bentonite, is a very fine clay that is used as a fining agent, especially in white wines. The very small Bentonite particles are abrasive and will damage the inner workings of most pumps. This is especially true for almost all positive displacement pump designs. The fine clay particles get in between the different surfaces inside the pump-head and then sand away the rotors and chambers of the pump. Significantly, this doesn't include peristaltic pumps because the inner surfaces of the peristaltic tube don't slip or rotate relative to each other.

### In the Barrel Room

Filling barrels requires some way to precisely meter the wine into the barrel. One can use a positive displacement pump, like a peristaltic pump, for example, with variable frequency drive, which I would recommend for all positive displacement pumps, and a remote control. Alternatively, one can use a pump that can pump against a closed valve without splitting hoses, like centrifugal or air-operated diaphragm pumps.

Emptying barrels requires a pump that has enough suction lift (AKA "self-priming") to get the wine over the top of the barrel and to the pump. Since they are self-priming, peristaltic pumps can be a good fit for this use.

### Filtration

Usually, filtrations also require a pump that delivers a predictable flow. Filtration is one winery operation that also requires a pump that can generate significant back pressure. Fortunately these are intrinsic attributes of all positive displacement pumps including those with flexible impellers. Since the pump throughput is proportional to the pump speed for positive displacement pumps, a variable speed pump can be used to regulate the pressure across the filter. This need for speed control is why many flexible impeller pumps are driven by variable frequency drives these days.

When sizing a pump for filtration, the size of the filter determines the minimum size of the pump that can be used. It should be noted, however, that few wineries have filters that are so large that they need a pump bigger than 1½ inches.

### Bottling

From the perspective of the pump, bottling is just another filtration. While this should be apparent for any wine that is sterile-bottled, even the 10-micron "bug catcher" filters used to protect a filler require a pump that can generate enough back pressure to force the wine through at a controllable rate.

When bottling, the size of the filler determines minimum pump size that should be used. In practice, it takes an extremely fast bottling line to outpace a 2½-inch pump.

## WHAT IS BEING PUMPED ANYWAY?

The preceding list of winery operations is organized, more or less, in the order that they would occur during wine production. If we look at things in terms of what is being pumped rather than focusing on winery operations, we see that we're pumping grapes, juice, must, wine, pomace, marc, lees or Bentonite. We can lump these into a few categories: liquids (juice and wine), suspended solids in solution (grapes, must, lees and Bentonite), separated solutions (pomace and marc) and abrasive solutions (Bentonite).

Pretty much any winery pump design can move liquids like juice and wine while most can move solutions with suspended solids. The only limitations on the last category are the winery's tolerance for any maceration of the suspended solids. Separated solutions require a positive displacement pump and generally need to have a pump that has been fitted with a hopper and feed auger. Abrasive solutions like Bentonite most likely will damage any pump except centrifugal and peristaltic pumps.

## ATTRIBUTES

### Size

Pump size is usually the first attribute most people consider when shopping for a pump. In the particular case of peristaltic pumps, there aren't too many examples of pumps that are too small to pass suspended grape solids. Pump size, therefore, plays a role in determining if the pump is capable of pumping grapes, must, pomace and marc.

Assuming that the flow rates are high enough to suit the winery's needs, a 2½-inch peristaltic pump can be used for most wine movements, including filling and emptying barrels and pump-overs. However, it's probably best to stick with 3-inch or larger peristaltic

**Peristaltic Pump Vendors**

| Vendor | Location | Telephone | Web | Brand(s) |
|---|---|---|---|---|
| **American Tartaric Products, Inc.** | Windsor, CA | 70-7836-6840 | *www.americantartaric.com* | Siprem |
| **Criveller California Corp.** | Healdsburg, CA | 707-431-2211 | *www.criveller.com* | Enoveneta |
| **Davison Winery Supplies** | McMinnville, OR | 503-472-1711 | *www.dwinesupplies.com* | Della Toffola |
| **Della Toffola USA** | Santa Rosa, CA | 707-544-5300 | *www.dellatoffola.it* | Della Toffola |
| **Inoxpa USA, Inc.** | Santa Rosa, CA | 707-585-3900 | *www.inoxpa.com* | Inoxpa |
| **Martagan Associates** | Victor, NY | 585-742-3700 | *www.martagan.com* | Raynox |
| **P&L Specialties** | Santa Rosa, CA | 707-573-3141 | *www.pnlspecialties.com* | CME |
| **Prospero Equipment Corp.** | Pleasantville, NY | 914-769-6252 | *www.prosperocorp.biz* | CMA |
| **St. Patrick's of Texas** | Austin, TX | 512-989-9727 | *www.stpats.com* | Zambelli |
| **TCW - The Compleat Winemaker** | St. Helena, CA | 707-963-9681 | *www.tcw-web.com* | Ragazzini |

pumps for moving grapes, must, pomace and marc. Note that most of these operations are going to need a hopper feed as well.

As the size of the winery increases, then it is most likely that it will invest in more pumps before it invests in larger pumps. Pump size is only indirectly related to winery size insofar as it is the size of the individual wine-lots that really matter—but these tend to increase as we go from a small winery to a large one. All but the largest wineries should find that a 3-inch peristaltic is adequate for most operations; they'll just want to have more than one as their size increases. Very large facilities that want to use peristaltic pumps to move must will want the largest, fastest models available.

### Other Attributes

Any peristaltic pump considered for general use in the wine industry should have stainless steel hose connections, easily replaceable "U-tube(s)," a variable frequency drive, a wired or wireless remote, a watertight electrical enclosure and be mounted on a stainless steel cart. The watertight electrical enclosure and stainless steel for any metal parts that contact wine features are essential on any winery equipment because wineries are wet places. Stainless steel should be the only *metal* that touches wine. The variable frequency drive, and associated control, allows the pump speed to be set anywhere between zero rpms and the pump maximum. The remote control allows the cellar worker to control the pump while standing some distance, filling barrels or tanks, for instance. I consider these attributes to be non-negotiable. If the pump doesn't have them, I don't want that pump in my winery.

One of the most important attributes to consider, when shopping for peristaltic pumps, is the availability of replacement tubes. The U-tubes do wear out with time. Almost the first question one should ask the vendor is, "Do you keep replacement tubes in stock locally?"

### Cost

Peristaltic pumps seem to have a reputation for being expensive, but this seems somewhat undeserved considering that they tend to cost about the same as a comparably sized rotary lobe pump. A 2.5" peristaltic normally costs about $10,000 while the 3" and larger models are generally priced starting around $12,500. Of course, things can get pretty expensive as the pump size is increased to the double-tube versions and as options like feed hoppers are added. It's also true that, given my typically aggressive recommendations for maintenance, a winery also ends up replacing the tubes pretty regularly, but this cost pales compared to the cost of repairing a progressive cavity or rotary lobe pump after it has ingested a vineyard staple, cross-arm or hose clamp.

## USAGE SCENARIOS

Here are a few (semi-)hypothetical examples to illustrate the type of situations where I think a peristaltic pump would be a good addition to a winery's equipment.

### Oregon Pinot Producer

For our first example, let's consider the case of a small winery in Oregon's Willamette Valley. The winery is primarily known for its Pinot Noir, but the bulk of its production is Pinot Gris from mid-valley vineyards to the south and west of Corvallis. The crushpad is a pretty simple affair. The winery is a simple one-story operation and not set up for using gravity as the only way to move wine. Pumps of some type will be needed.

For each lot of the Pinot Noir: The Pinot Noir is destemmed directly into macro bins for fermentation. As a result, there is no need to pump the Pinot Noir prior to fermentation. During fermentation, the winery punches down (pigage) rather than pumping over. The macro bins are dumped directly into the press, but a pump is needed to pump the wine from the press sump to the setting/surge tank. The wine is sent to barrels for malolactic fermentation (MLF) and élevage almost immediately. After MLF, the wine is racked off of the gross lees to a mixing tank for mixing, labwork and $SO_2$ adjustments prior to being sent back to barrels for six to nine months for further élevage after which the process is repeated.

Now Pinot Noir is notoriously temperamental, and it has the reputation for not liking pumps. Already the winemaker has minimized pumping on the crushpad by using a lot of forklift-powered gravity-dumping to get grapes into his destemmer and into his press. Furthermore, barrels are emptied using nitrogen gas and a **Bulldog Pup®**. The concern for the Pinot Noir was that the necessary wine movements for building blends and bottling should be as gentle as possible.

While Pinot Noir garners most of the attention, Pinot Gris is really the wine that keeps the winery in business. The winemaker has discovered that if one actually lets the grapes get ripe, Pinot Gris can get a hazelnut-like nuttiness. However, this character can be somewhat ephemeral, so the winemaker has decided to minimize pumping and use as gentle a pump as possible.

Since the winery's needs are pretty much confined to moving juice or wine, a 2.5-inch peristaltic pump was purchased.

### Virginia Viognier

I've made a fair amount of Viognier over the years. Although I have made and tasted several Viogniers that were good, I consider it to be just about the most frustrating varietal with which I have ever worked. In 20 years, I have never, and I mean never, had a Viognier that was as good out of the bottle as it was out of the tank. There are delicate orange-blossom and floral aromas that I get out of a tank sample that are missing by the time the wine is bottled. The only way I have found to preserve some of these notes is to be extremely gentle with the wine during the post-fermentation processing. This is where the peristaltic pump comes in. The design has become my preferred pump for moving delicate varietals.

It's a pleasant surprise to find a number of tasty Viogniers coming out of Virginia these days. With this in mind, let's take the hypothetical case of a mid-sized Virginia winery specializing in Viognier. The winemaker has decided that she doesn't want to press whole clusters but wants to keep the destemmed berries intact between the destemmer and the press.

The winery purchased a hopper-equipped 3-inch peristaltic pump for moving the berries from the destemmer to the axial feed of the press. After har-

## Nitrogen Safety

One would think that since we regularly breathe nitrogen gas—our atmosphere is about 70 percent nitrogen—there would be few safety issues to using nitrogen as inert gas in the winery. However, nitrogen's very ubiquity is what makes it dangerous. Nitrogen doesn't cause respiratory distress. You can breathe pure nitrogen without being aware that you're not getting any oxygen as you inhale. It can displace the oxygen out of a confined space, and we wouldn't know it without an oxygen sensor.

vest, the hopper is removed from the pump so that it can be used for wine movements and filtrations.

### A Giant on the Central Coast

For our last hypothetical scenario, let's look at the case of a large winery on the Central Coast. Let's say the winery has a bit more than 50,000 tons of crush capacity, has a parent company with significant wine holdings in Australia, and crushes large volumes of both hand-picked and machine-harvested fruit. At this scale, speed and efficiency are everything. The winery has deployed a small fleet of the largest, hopper-equipped peristaltic pumps available for moving berries from the destemmers to the fermenters and for moving must from the fermenters to the presses.

### WHAT AND HOW TO BUY

Most wineries need a pump for their filtrations regardless of how much, or how little, wine they produce. This requires at least one pump that can generate significant pressure at the pump outlet. Theoretically, all positive displacement designs, including peristaltic pumps, have the potential to fulfill this role; but in practice, and except for integral piston pumps on lees filters, the U.S. wine industry relies upon flexible impeller and rotary lobe pumps for filtration. Smaller wineries tend to prefer the flexible impeller designs for their general purpose pumps while larger wineries tend to prefer the rotary lobe pumps in this role. It should be noted, however, that there is considerable overlap in these preferences for wineries with annual production levels between 2,500 and 25,000 cases per year. As we have seen, however, we can include peristaltic pumps as a filtration-capable pump as well.

Pumps are a category where larger just means more. Increasing the winery size tends to cause the winery to need more pumps before they just need larger pumps.

Past *WBM* Winery Equipment Surveys have borne out this observation by showing that the likelihood that a winery will buy at least one new pump dramatically increases as winery size increases (see *WBM*, March 2007).

As we can see in the above section, this all resolves to a pretty simple rule of thumb: If the winery is going to be moving must, it should get a pump that's at least 3-inches; otherwise, the winery should get a 2½-inch pump.

As a side note, this is why I usually recommend that pretty much any winery should buy a 3-inch pump as it's a jack-of-all-trades pump. Usually this recommendation is filled by the purchase of a rotary-lobe pump, but peristaltic pumps are good candidates for a jack-of-all-trades pump. Indeed, as we have seen, peristaltic pumps can handle jobs like pumping Bentonite that would damage a rotary lobe pump or pumping things like marc that a rotary lobe pump can't. **wbm**