DS64

UNIVERSITY OF FLORIDA
IFAS EXTENSION

Milking Management III - The Vacuum Pump Milking System[1]

Bray, D. R.[2]

The vacuum pump is the heart of the milking system. Its purpose is to remove air from the system, thus creating a vacuum. Pump capacity is a measure of how fast the pump can remove air and is, therefore, measured in cubic feet of air per minute (CFM). Pump capacity can be expressed as American Standard (ASME) or New Zealand Standard (NZ). One CFM ASME equals 2 CFM NZ. It is similar to measuring the pumping capacity of an irrigation system in gallons per minute. Since the rate at which a pump can remove air depends on the vacuum level, all pump capacity ratings are standardized by measuring them at 15 inches of mercury. At that vacuum level, a pump removes air at a constant rate.

The vacuum pump needs to be able to remove air at least as fast as it is let in during milking (air usage) in order to help keep the vacuum level constant. If air enters the system faster than the pump can remove it, the vacuum level will drop. If pump capacity is greater than air usage (which should always be the situation), the excess air pumped must be let in through the vacuum controller (regulator).

The balance tank or vacuum reserve tank serves two functions. First, it acts as a cushion to absorb any sudden inrush of air, which might result in a vacuum drop. Second, it acts as a trap for liquid while the system is operating, thus protecting the pump from internal damage. If two pumps are running the system, each should be connected to the balance tank. Usually, only one balance tank should be used. Excess tanks in the system create dead spots and interfere with the vacuum controller's ability to create a stable vacuum in the system.

Leakage in the vacuum system should not exceed 10% of the vacuum pump capacity. To determine the amount of leakage, all units are removed from the system, and the air flow is measured at the receiver jar. Leaks are determined by subtracting the CFMs measured at the receiver jar from the actual pump capacity.

Once you remove leakage from pump capacities, you will see that the usable CFMs per unit is much lower. Excessive leakage can be quite expensive since you may need a larger pump to stay ahead. Most leaks are found in the balance tank, especially if it is old and rusty and has long plastic lines that sag and come unglued. If you would like to check your system for leaks, take a piece of plastic wrap and place it loosely around the pipe joints. The plastic

1. This document is DS64, one of a series of the Animal Science Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Original publication date April 1993. Reviewed June 2003. Visit the EDIS Web Site at http://edis.ifas.ufl.edu.
2. Extension Agent III, Dairy Science Department; Associate Professor, College of Veterinary Medicine; Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville FL 32611.

wrap will be sucked around the pipe joint wherever it is leaking.

On the average, Florida dairies have sufficient pump capacity; however, those on the low end of the range should observe their vacuum gauge regularly to insure that line vacuum remains stable.

Vacuum pump maintenance is important and includes the following steps:

- Check belts - replace if worn or oil-covered, and keep tight.
- Keep the motor clean.
- If you have an oil reclaimer, clean the filter.
- If you have a water pump, replace the water hoses at the first sign of leakage. Many of them get clogged with algae or scum. The pump may burn up if it doesn't get enough water.
- Check balance tank. The drain on bottom should seal off. Replace it if old and rusty.

Most Florida dairies have large enough vacuum pumps, but have an excessive number of leaks. Before you buy a new vacuum pump, make sure that leaks are not the cause of your low capacity. Worn or loose belts also contribute to low pump performance.

VACUUM CONTROLLERS (REGULATORS)

A survey of Florida dairies revealed that an unacceptably high percentage of vacuum regulators were not working properly. This condition can easily translate into a severe mastitis problem. In this section, we will examine the role of the controller and describe how to maintain it and check for malfunctions.

The vacuum pump removes air from the system at a constant rate, but air is used at a highly variable rate in the milking operation. Vacuum controllers are installed in the milking system to hold the vacuum level constant. The controller does this by admitting variable amounts of air into the system. When little air is used in milking, more is allowed in by the controller. If no air is let in, it could create a vacuum of nearly 30 inches Hg, much higher than you want for milking. If excess air is allowed to enter the system, the line vacuum will drop below the desired level.

A good quality controller can sense very small drops in vacuum, which occur as air usage increases, and respond by admitting less air into the controller. This keeps the vacuum level constant. The controller should be able to hold the vacuum constant over its whole range of air flow capacity, and, when necessary, it should be able to shut down so that almost no air is admitted. The capacity of the controller should be more than the capacity of the vacuum pump.

Type of Controllers

Diaphragm-type controllers generally have the ability to sense small changes in vacuum, respond quickly, and hold the vacuum constant over their whole range of capacity. The most common diaphragm controllers are the Sentinel, Westfalia, DeLaval Servo, and D.E.C. Servo. The Surge Equalizer II is quite acceptable also although it is a spring type.

Old dead weight controllers are not very sensitive and they should be replaced. A million-dollar dairy should not be ruled by an old five-dollar controller.

Location of Controllers

The controllers should be placed in the system according to manufacturer's recommendations and placement will differ according to manufacturer. Controllers usually are placed on the main vacuum line that runs from the pump to the trap or the balance tank. It is important that they be located in a clean area that also is accessible for service. Installation in the parlor usually is not satisfactory because of the noise it produces. Some controllers must be double elbowed if installed on the balance tank. Many have sensors as part of the unit. They must be located in front of the controller and must have a correct length of tubing between the sensor and controller. Because of the complexity of those controllers, it is important that they be installed according to directions.

Controller Response

If you have your system analyzed, be sure to have the controller response checked. This may be done by removing the probes and placing an orifice flowmeter in the receiver jar, admitting air in 10 CFM bursts. There should not be more than one-half inch change up to 90% of the system's capacity. If equipment to check your controller is not available and you keep your controller clean and it is of the newer type, you should have no problems, as long as you can see no fluctuation on the vacuum gauge while milking. If you have the old dead weight controllers, you do not have to check them. They were not responsive when they were new: replace them.

Maintenance of Vacuum Controller

Because of the complexity of these controllers, follow directions for cleaning. If the unit has filters, clean them when they are dirty, usually once a month, or more often if located in a dirty area, or you have a large pump. Large pumps require that all excess air must come through the controller. Most controllers that are fitted with filters must also be washed internally. In some, only the bottom half is washed while others may be completely washed. Most controllers need no lubrication and should not be oiled, which causes dirt and dust to collect and clog.

Vacuum controllers are a very important part of the milking system. No dairy should have an old controller, since new models are much more sensitive. Controllers should be installed correctly and kept clean so they function properly. Maintainance costs are a small price to pay to insure against a major mastitis problem.

PULSATORS

The pulsator is the device that alternates vacuum and atmospheric air between the liner and shell and is responsible for the milking process. Vacuum at the teat end removes the milk by a pressure differential. This is called the open or milking phase.

The massage, or rest, phase begins when the pulsator admits atmospheric air in the chamber between the liner and shell. This collapses the liner on the teat end and provides massage to the teat. The massage cycle is necessary because while the milk is removed during the milking cycle by vacuum, this vacuum also draws blood and body fluids down into the teat. Without adequate massage, the teat and teat end may be damaged, thus causing an increase in mastitis.

This action makes the pulsator very important in the milking process. If the milking phases are not performed adequately, quarters will not be milked or milked very slowly. If the massage phase does not take place, edema of the teat will occur and the quarter will not be milked properly. In addition, teat end damage will occur. Either situation is bad for udder health.

The mastitis survey indicated that only 25% of all dairies in Florida had all pulsators working properly. Conversely, 75% of the dairies had malfunctioning pulsators.

Type of Pulsators

- Electric - usually direct current, constant pulsation.
- Pneumatic - these run by vacuum. Most don't function well in Florida because of high humidity and feed dust.

Pulsation Rate

Pulsation rate is the number of times per minute the milk phase and the massage phase occur (the two phases equal one cycle). The most common rates are between 44 and 60 pulsations per minute. Forty-four pulsations per minute is quite common in Florida, but this is slow milking. Recent research results have demonstrated that 60 pulsations per minute may be the best choice.

Pulsation Ratio

Pulsation ratio is the proportion of one cycle that the milking machine is in the milking phase versus the massage phase. Most common ratios are between 50:50 and 70:30. In theory the higher the ratio, the faster that milking will take place; 60:40 seems to be the most common in new installations.

Analysis of Pulsators

There are several types of equipment used to check pulsator performance. Earlier machines used bellows and did an adequate job of graphing pulsator function. However, more advanced electronic testing equipment is now available. Both are acceptable to determine pulsator function. All equipment dealers and some veterinarians have this equipment.

Pulsators should be checked regularly. In Florida, where dairies are large, it would be wise for most dairies to buy their own equipment and check all pulsators each month.

If you clean your pulsators each month, replace rubber parts. If all pulsators sound the same when running, they are probably working properly. Clean pulsators are very reliable. Remember that, as with vacuum controllers, pulsators need not be eligible for social security before they are retired. If they are old and beat up, buy new ones.

Pulsator Maintenance

Pulsators should be cleaned at least once a month in Florida. Our unique herd size, hot humid weather, and the use of dusty feeds are very hard on these machines. If the small air inlet is blocked, no air will be admitted, no massage takes place, and the teat end of every cow milked by that unit gets damaged.

Epoxy-sealed pulsators may be cleaned by sucking water through the hoses. Make sure that the air inlet gets washed during this process. Other types of pulsators should be taken apart and cleaned monthly. Rubber piston caps should be replaced every 6 months.

Many new installations now have filtered pulsation air. This is an excellent idea and should decrease the frequency of required pulsator maintenance. But even filtered types should be dismantled and cleaned, with rubber parts replaced every 6 months.

With 75% of the dairies in Florida having malfunctioning pulsators, mastitis losses probably are high in these herds. To prevent disease, clean pulsators every month. Most pulsators do not malfunction because they are mechanically faulty, but because they are dirty.

THE MILKING CLUSTER

The cluster includes the liner, shells, and claw.

Types of Liners

- Most liners used in Florida are one-piece narrowbore types and should be replaced after 1200 cow milkings.
- Stretch liners are used by a few dairymen in Florida. They should be replaced after 500 cow milkings.
- Silicone liners also are available and will last 6000 cow milkings. They are very expensive initially, but because of their extended life, their cost per milking is equal to or less than regular liners.

Shapes of Liners

Round is the most common shape in Florida. Square liners also are quite popular in some areas of the state. Shape of liner used is more a matter of personal preference than a result of scientific evidence as to which is best.

One of the most important management considerations for liners is the frequency with which they are changed. The reason for replacing liners after the recommended number of milkings is that they stretch and no longer provide adequate teat massage.

Formula for determining number of days to use liners: Liner life x no. of units Times/day milking x no. cows in herd = no. of days For example, using liners with a 1200 milking life, 20 units, twice a day milking, and 500 cows: 1200 x 20 2 x 500 = 24 days of liner life Because of the large number of cows milked in Florida, it usually is more labor efficient to leave the liners on the units until discard time, rather than dismantling them each week. This works fine up north where the dairyman milks only 30 cows with three units two times per day.

Vents for Liners and Claws

It is very important to vent the milking cluster. This facilitates the movement of milk away from the claw and increases milking speed and prevents flooding of the claw.

Many liners used in Florida are already vented when purchased. If the liners are vented the claw vent should be blocked off, but this is easier said than done. Stainless steel claws may be silver-soldered shut; epoxy glue may work for a limited time. Superglues have been known to shatter some plastic claws.

If both the liners and the claws are vented, too much air is admitted and this decreases teat end vacuum and causes too much turbulence inside the claw. This should be avoided if at all possible. It is also advisable to check the vents at each milking to determine if they are open.

Milker Claws

Most claws today are of adequate size and capacity. Size and shape of claws used are a matter of personal choice. Some people prefer stainless steel to plastic.

New Claw Designs

The quarter milker has a separate chamber or milk tube to separate milk from each quarter. This may prevent cross-contamination by mastitis. If you're in the market for new claws, this might be a good choice.

Claw Shut-offs

One of the most important components is a device to shut off the vacuum to the teats before removing the unit from the cow. Unfortunately, this type of device is not on most claws or is not used if installed. A hose clamp shut off also will accomplish this task. One advantage of automatic take-offs is that they shut off the vacuum before machine removal.

Research has shown bad effects when the units are removed without breaking the vacuum. This means that bacteria may be propelled into the teat end and cause mastitis.

Maintenance of Liners and Claws

Liners should be changed according to directions. Claws should be washed externally daily. The vents should be checked at each milking. If the claws have gaskets, they should be replaced once a year.

The cluster is a very important part of the milking system. Replacing liners at prescribed intervals, keeping vents open, and shutting off vacuum to the teats before removing the unit will help reduce mastitis losses.

LINE VACUUM

The vacuum level at which cows are milked has a dramatic effect in the milking operation. You need a reliable means to measure your system vacuum level. The most common method is with a vacuum gauge, but the most accurate is with a mercury manometer. Both devices can give distorted readings. Gauges get wet and/or dirty and lose accuracy. If the gauge reads the same when the pump is on or off, or does not go back to zero when the pump is off, it needs replacing. Mercury manometers can collect water and give distorted readings.

Although mercury manometers are very accurate and are preferred for that reason, they may also pose a health hazard. Mercury is toxic, and if the manometer should break, the mercury could be drawn into the vacuum system and contaminate the milk. The manometer could break and mercury might get on someone's hands or body, causing harm. If you have a mercury manometer, use caution.

The most reliable method for vacuum measurement is using one gauge in the parlor or flat barn and another in the office or other clean area. Measure at each milking, and if they both give the same reading, they probably are correct. Have your milking equipment dealer check them.

The vacuum level of the system should be measured from the main vacuum line, not the pulsator line. Measuring on the pulsator line will give false readings by measuring fluctuations from pulsator action.

The vacuum gauge is an excellent tool for analyzing the milking system. It can be used to check the vacuum level at each milking, making sure it is at the prescribed level. A rise in vacuum level is an indication that the vacuum controller is dirty.

If the vacuum level fluctuates up and down, this indicates that the controller is dirty and sticking and is causing vacuum fluctuations. If the controller is clean and working properly and the vacuum level drops, this means a shortage of pump capacity. This may result from worn or loose belts on the pump, or your pump needs repair or replacement. Additionally, it could be caused by leaks developing in the system. If the vacuum gauge or manometer is suspect, replace it.

The old rule of thumb has been to set the vacuum level at 12.5 inches Hg for low lines and 14 to 15 inches Hg for high lines. Little research data are available on the optimum level. A system set lower than 11 inches Hg will cause units to fall off the cow at peak milk flow. Research has demonstrated that vacuum levels above 15 inches Hg damage teat ends, a precursor to mastitis organism entry.

To eliminate liner slip or units falling off, raise the vacuum level until it stops, as long as the vacuum level does not exceed 15 inches Hg. If units continue to fall off, you may wish to consider using different liners.

In Florida, where most cows are being milked 3 times a day, 15 inches Hg may be the best choice of vacuum level. Raising the vacuum also may increase milking speed, and most milkers find that eliminating liner slip means that units stay in place.

MILK METERS

If you are on DHI, or use milk meters on weigh day, nobody has to tell you what a problem it can be to milk on these days. This is especially true if you milk at a low vacuum level, because milk meters further decrease the vacuum level at the teat end. The milk meter is a constriction in the line, because it has several chambers for the vacuum to go around. The problem is compounded if you do not have adequate pump capacity or the vacuum controller is sticking. Inadequate pump capacity will drop the vacuum level in the system when air usage exceeds pump capacity. A sticking controller at a lower setting than the vacuum level will cause the same problem.

The best way to get through weigh day is to increase vacuum level 2 inches if below 15 inches Hg. Remember to restore the original setting after the meters are removed so you don't damage teat ends.

The first step to ensure proper line vacuum is to install reliable gauges. Under Florida conditions, that is best achieved by installing one vacuum gauge in the milk room and one in the parlor.

Line vacuum or vacuum level is very important to udder health since liner slip and fall-offs are reduced at 15 inches Hg. Remember not to exceed this level. Replace malfunctioning gauges.

One of the easiest ways to increase milking speed, prevent fall-offs, and have a smooth running test day, is to increase the vacuum level.

MILK LINES AND BALANCE TANKS

The sizing of the lines or pipes in the milking system is important to provide proper milking vacuum. Systems that are not balanced (that is, the lines are not compatible with vacuum pump size) may cause measurable vacuum differentials in the system and make vacuum level control difficult. Restricted pipes not only can cause unstable vacuum conditions but they may even cause losses of vacuum capacity of the pump from increased vacuum levels at the intake. Installing pipes larger than necessary serves no useful purpose.

Milk Lines

In Florida where most milking operations are large, most milking equipment installed is for 3-inch lines, since that is the largest diameter sold. The current 3A standards for sanitary milk pipe size are shown in Table 1.

Much controversy still surrounds the pipeline size. Australian researchers suggest that up to 12 units per slope may be used on a 3-inch line. Recent research at the University of Florida demonstrates that 16 units can be installed per slope of a 3-inch line. Research at Cornell University demonstrates that

dead-ended lines flood more readily than looped milk lines. A looped line permits vacuum to be available from either end of the pipeline. Thus, high producing cows will not reduce vacuum from the milker unit upstream from that cow. No system should be installed without having a looped milk line.

All milk lines should have at least 1 to 1.5 inches slope per 10 feet. Many milk lines were installed with sufficient slope, but, because people step on them, they have become level over time. Many barns do not have sufficient slope because in long barns the line would need to be very high at one end. The line also would be low at crosswalks.

Vacuum Lines (From the Pump to the Trap)

The most critical length of pipe is from the pump to the vacuum controller or controllers, where the highest volume of air is moved in the system. The vacuum controller admits air into the system, which is exhausted through the vacuum pump. If a 200 CFM pump is used, only the CFMs actually used are in the system. The rest go in through the vacuum controller and out through the pump. In order to keep the vacuum under control, this pipe must be of sufficient size to keep air velocity low enough so that the vacuum controller can function properly and keep the vacuum level constant.

Air velocity depends on the diameter of the pipe and the length of the pipe from the pump to the vacuum controller.

If a vacuum pump with a 20 HP motor or 200 CFM only has a 3-inch outlet, keep the distance between the pump and the vacuum controller as short as possible. In most installations, this distance is usually less than 50 feet. If a large 20 HP vacuum pump has a great distance between the pump and the controller, it might be wise to move the controller closer to the pump.

Several important factors affect installing a main vacuum supply line. First, install a Y or tee with a shut-off valve (gate or slide) next to the vacuum pump. With these, the pump capacity can be checked easily with a flowmeter by the dealer or the person analyzing the milking system. The second is to install tees instead of elbows in parts of the line. This allows washing the lines with a hose and water.

Pulsator Lines

Much confusion still exists on the proper size of pulsator lines. The latest research indicates that most pulsator lines are oversized. Up to 20 pulsators can be used on a 2-inch line. A 3-inch line will handle 20+ pulsators. Research also has shown that the line need not be looped. A pulsator uses only about 1 CFM in the milking process. This is a small amount of vacuum, so the pipe need not be large.

In Florida, where most milking systems are large, the use of 3-inch plastic pipe is common. The advantage is in the structural stability provided. The pipe does not sag as readily as smaller plastic pipe, and it is easier to tap pulsators into a 3-inch line.

Pulsator lines should be installed with tees and caps so that they can be cleaned out with a hose and water. The pulsator line should lead directly into the main balance tank. It does not need its own separate balance tank.

Balance Tanks

The role of the balance tank, or vacuum reserve tank in the milking system often is misunderstood. In the past, it was called a reserve tank because vacuum pumps usually were very small and this tank provided a reserve of vacuum to draw from if a milking unit fell off. The tank also acted as a trap to keep milk and cleaning solutions out of the vacuum pump.

Most modern milking systems use a 50 gallon reserve tank. The balance tank acts as a trap. It is needed when two vacuum pumps are installed on a system and provides a means of plumbing the pulsator lines into the system. The tank needs to hold no more than 40 to 50 gallons. It can be made of plastic, stainless steel, or galvanized metal. It should have a self closing drain on the bottom for liquids when the pump is off. This drain valve should be designed to close tightly, since otherwise a large vacuum loss could occur.

The problem with oversized or multiple balance tanks is that they interfere with the vacuum controller's ability to keep vacuum level stable in the system. Today's sensitive, fast acting controllers have the ability to control the whole system

instantaneously. Balance tanks create big vacuum pockets and may interfere with the controller's ability to regulate.

Today's modern milking systems should be designed so that all components are compatible. The milk line should be looped and have 1 to 1.5 inches of slope per 10 feet. A single line is usually easier to keep clean than a double line.

The main vacuum line should be of sufficient size and easily cleaned. The pulsator lines should be sturdy to prevent sags and be cleanable. The balance tank keeps liquids out of the pump and also is needed for a two-pump system. The practice of making everything larger than needed not only is expensive, but is not as efficient as a balanced system.

PARLOR AUTOMATION

As the time comes to build a new milking facility or remodel an existing system, you will ask important questions. What equipment should be added to improve labor efficiency? Will new equipment reduce mastitis in the herd?

Much of the new equipment is very expensive. Labor requirements may be less in number of people employed, but dairy workers may need to be more diligent to operate and maintain this equipment. If your present milking equipment is working properly now, the addition of new equipment will not reduce mastitis. If mastitis is due to poor management practices -- carelessness, dirty conditions, and malfunctioning machines -- changing equipment will not cure the problem.

Automatic Take-off Units

Many improvements have been made in ATOs since they first were introduced. Reliable solid state controls have replaced old electronics.

ATOs can reduce labor requirements. When they are first installed, some old cows will not milk out completely. Your milkers must be alert to recognize this and reapply the unit to partially milked cows. Heifers usually milk out well with ATOs and once trained will continue to do so throughout their life as long as they do not get injured teats.

The role of ATOs in reducing mastitis is questionable. It was thought that overmilking caused increased mastitis, but research has shown that overmilking is not a factor in increasing mastitis in herds with relatively low percentage of infected quarters. Overmilking increases the length of time for organisms to cross-contaminate into another quarter of the same cow. If presently you have a highly infected herd, ATOs will not eliminate the high level of infection. Other management practices must be implemented. One big advantage of ATOs is that vacuum is shut off before units are removed, thus preventing mastitis. In large herd situations the use of ATOs is practical. It allows fewer milkers and cows will be milked the same way at every milking.

Backflushers

Backflushers were introduced several years ago in an effort to control Mycoplasma mastitis. They usually are very expensive to purchase and maintain. Most automatic backflushers have four or five cycles -- water rinse, iodine rinse, clear water rinse, and positive air dry cycle.

It was thought that sanitizing the liners between each cow would stop the spread of Mycoplasma mastitis. Field observations have shown that this may be the case. In herds where every cow is cultured for the presence of mycoplasmas and positive cows are culled from the herd, these same observations might have been made in the same herds if no backflusher were present. Other field observations have been made in which Mycoplasma increased in herds with backflushers where they did not sample and cull the positive cows. Little or no research data are available to determine if backflushers will stop the spread of Mycoplasma mastitis.

Research from the Universities of Florida, Kentucky, and Pennsylvania demonstrate that backflushers reduce the number of bacteria in the liner between cows milked, but this does not reduce the number of bacteria on the teats of the cows. Infected teats are the problem to solve, not contaminated liners. There is some evidence that backflushers will reduce the spread of some contagious organisms, but this can be accomplished at a much lower cost by teat dipping.

British researchers have compared the use of teat cup pasteurization between milking of each cow versus no pasteurization, and found that the former gave a small decrease in mastitis, but not enough difference to pay for the cost.

Because of the high initial cost and daily maintenance of backflushers, and because their benefits have not been effectively demonstrated, the purchase must be questioned.

Quartermilkers

Another new product on the market is the divided claw or quartermilker. The purpose of this device is to prevent the cross-infection of mastitis from one quarter to another during the milking process. If you have a low infection level, not much benefit would be seen using this type of claw because there is little mastitis to spread. If you have a highly infected herd, again, not much difference will be seen since most of the quarters already are infected.

The only problem that might arise with this type of claw is its durability. Some of them have four individual hoses connecting quarters to the milk line. This increases the chance of them coming apart. The unit also should be able to withstand being stepped on by cows.

While no dramatic evidence has been found that the use of a quarter-milker will greatly reduce mastitis, it certainly couldn't hurt. If you are in the market for new claws anyway, they might be a wise choice. If your present claws are in good condition, you may wish to wait until they need replacing and then try the divided claws to see if there is any benefit.

Wand-type Teat Sprayers

While this device may not be considered part of milking equipment, its benefit makes it very much a part of the milking process. As a matter of fact, getting proper coverage of teat dip on the teat is the most important part of the milking process.

While applying teat dip with a dip cup provides the best coverage, in Florida's large herd conditions, it is tiring work. Spray bottles provide very poor coverage even on the teats facing the sprayers, and usually no coverage occurs on the far side teats.

If teat dipping is suspect in your herd, you may wish to purchase a wand-type teat sprayer. They are relatively inexpensive, and milkers seem to use them well. Importantly, wands do provide good coverage of teat dip. Some claims are made that they use less dip, but most dairymen find they use the same amount as dipping with a cup. However, if they get good coverage, they are worth the price of more dip.

Filtered Pulsator Air

Many new installations are being equipped with filtered air. This is no more than a length of 3-inch plastic pipe with all the pulsator air inlets inconnected to it by a short length of hose,and one or more air filters on the pipe. Not only is this a good idea for new installations, but also for existing systems. The cost of this addition is very low and the benefits are great. Remember that 75% of the dairies in Florida have at least one malfunctioning pulsator. The main reason for malfunctioning pulsators is that they are dirty. The filtered air will reduce greatly the amount of dirt that enters the pulsators. Because filtered air will not protect pulsators when the hose becomes disconnected and sucks up manure, they should be cleaned whenever this happens, either by running water through the pulsator hoses in sealed pulsators or by dismantling other types. Take apart pulsators every 6 months for cleaning and inspect rubber parts. Change dirty filters or the pulsators will not function. To prevent moisture collection in this line from entering the pulsators, position the nipples on the filtered air line upward.

Purchase of new equipment, when needed, to upgrade a milking system is usually a wise decision. Automatic take-offs, if used properly, can reduce labor requirements. Wand teat sprayers can be beneficial if you are not getting good teat dip coverage. Other equipment may or may not have value in reducing mastitis. There is no shot in a bottle or piece of equipment that can overcome poor management practices.

KEEPING THE SYSTEM CLEAN

Cleaning the milking system is one of the most important chores on the dairy. High bacteria counts usually are caused by dirty equipment or poor cooling of the milk. Cows with mastitis usually are not the cause of high bacteria counts.

Cleaning the pipeline should begin as soon as milking ends, not after the parlor or flat barn is washed. Just as the parlor is harder to clean after it dries, the pipeline also is more difficult to clean.

Prerinse

The first step is to pre-rinse the system. Use 95 to 100°F water and discard this water.

Washing

Next, wash the system for 8 to 10 minutes with water at least at 160°F and the correct amount of chlorinated cleaner. The water temperature should not drop below 110°F during the wash cycle; if it does, fat may be redeposited back on the pipelines. If the water is very hard, use more cleaner or a water softener to supply water for washing the pipeline and the bulk tank.

Every dairy should have a thermometer. Use it every month to check the water temperature in the wash vat at the beginning and end of the wash cycle.

Water Temperature

Water temperature at the tap does not always indicate what the used wash water temperature will be. Multiple hot water heaters may be set at lower temperatures. Use the hottest water in the rinse cycle, especially in systems with tube or precoolers. Also, if you have an insufficient hot water supply, the hot water may be gone before the wash cycle has started. If the bulk tank also is washed at the same time as the pipeline wash, you will need a very large supply of hot water to clean both systems.

Acid Rinse

The next step is an acid rinse to neutralize chlorine residues and prolong the life of the rubber parts of the system. You will also prevent mineral deposits, water spotting, and milk stone deposits. The water temperature for the acid rinse should be between 95 and 110°F.

Sanitization

Immediately before milking, the system should be sanitized with a product made especially for dairy installation. Liquid bleach or unknown bulk chlorines may work in the swimming pool but do a poor job in the pipeline.

Other Items to Clean

The air injector also is important for wash-up. If you don't have one, or it doesn't work well, you will have a high bacteria count. Air injectors slug the water for cleaning the top of the pipeline which otherwise won't get washed.

The pulsator lines and main vacuum line from the trap to the pump also should be washed every 6 months. High bacteria counts occur because of dirty vacuum lines, especially if the trap keeps running over with milk.

High bacteria counts due to poor or slow cooling of milk may result from dirty coils or low gas in the system. It is easy to detect poor cooling if you have an accurate thermometer on the tank.

Milking Equipment Cleaning Recommendations

A survey of milking equipment in Florida revealed that many of the pulsators and vacuum controllers were not functioning properly. Research has demonstrated that major mastitis problems can occur with malfunctioning pulsation and vacuum controllers. The most common cause of these malfunctions is a lack of regular maintenance. If you have not performed these maintenance chores in some time, now would be a good time to start. Here are some guidelines to follow.

Daily Wash outside of milk line, receiver jar and trap, and claws and hoses.

Two weeks or 1200 milkings Replace liners.

Monthly

- Remove pulsators and clean them.
- Replace filters and/or clean vacuum controllers.
- Wash trap inside and out.

Every 6 months

- Monthly cleaning as usual.
- Replace all pulsator rubber parts.
- Replace all pulsator hoses, air tubes.
- Replace receiver jar gasket.
- Replace all milk hoses.
- Replace rubber hoses and rubber hose nozzles used to wash udders (rubber hoses harbor bacteria).
- Flush pulsator and vacuum lines.
- Check belts on vacuum pumps.

Yearly

- Do monthly and 6-month cleaning as usual.
- Replace all wash line hoses.
- Replace trap gasket.
- Replace wash manifold cups.
- Replace belts on vacuum pump.

STRAY VOLTAGE

Stray voltage had been thought to cause mastitis, but research results have not shown this to be true. Stray voltage may increase somatic cell counts because of irritation. Since the voltage cannot inject bacteria into the teat, most damage may be exhibited by cows who are already infected with subclinical mastitis. These cows may not milk out completely and advance to clinical symptoms. Thus, the voltage did not cause the mastitis; it just brought it to your attention.

Cow's Reaction to Current

Stray voltage can cause behavioral changes in dairy cows. They may refuse to enter the parlor, kick while being milked, or show other abnormal behavior. Cows may not drink normal amounts of water when stray voltage is present. Voltage leak may be in a pasture water tank, not in the parlor or flat barn.

Dairy cattle are sensitive to 0.5 volt AC or about 2.5 mA (milliamperes). Cows react to the current, not the voltage. The dairy cow's resistance is about 250 to 400 ohms, about 0.1 that of humans. That is why they feel the electrical currents and you do not.

Measuring Stray Voltage

If you think stray voltage is a problem, make these checks:

1. Use a high quality volt-ohmmeter that can separate AC from DC voltage. AC current is the problem. DC voltage at low levels has little effect on cows, and all electric pulsators are DC powered. To test your voltmeter, hold a small flashlight battery between the probes of the meter with the meter on the AC scale. A meter that responds to DC current on the AC scale should have a 5 to 10 micro-farad capacitor located in series in the probes to the meter.
2. Install a 300 to 400-ohm resistor in parallel with the meter to duplicate the cow's resistance
3. Take measurements with an isolated, copper-clad grounding rod. Place the rod 50 feet from the building, using a 14-gauge copper wire between the meter and the rod.
4. Measure voltage on the primary and secondary neutral, the bulk tank, parlor, or stanchions. Water cups or tanks also should be checked. If the cows won't drink water, this will cause low production.
5. If you do find stray voltage with your meter, have a qualified electrician check your system thoroughly. Reduce the effects of stray voltage. Whenever a new parlor is built, embed wire mesh in the floor and bond all metal surfaces to the mesh. The grounded mesh should cover both the

stall floor and the pit area. Also, the mesh should extend into the holding area to minimize the chance of a potential difference.

In existing parlors, a number 10 copper ground wire can be laid in slots cut into the floor, connecting all metal structures in the parlor. The slots in the floor can then be grouted over. Isolating transformers also can be used in some cases.

Stray voltage can be very troublesome on dairies. If you determine there is a problem, contact your local power company and a qualified electrician to eliminate the problem. You also can contact your county agent for AE 55, *Stray Voltages in Dairies*, a fact sheet that gives more detail on this subject.

SIZING THE MILKING SYSTEM

The amount of vacuum used to operate the milking system is quite small, less than 2 CFM per unit. Extra CFMs are needed to compensate for vacuum losses that occur naturally in the system: head loss and resistance of pipes, elbows, etc. Thirty CFM ASME are needed in any system just to keep the system operating.

Leaks account for a 10% loss (the difference between pump CFMs and system CFMs). Milk meters, unit slippage, air leakage used when applying the unit, and unit fall-off also consume varying amounts of vacuum depending on the skills of the operators.

Stated vacuum requirements vary greatly and are based on personal bias rather than research. The usual method is expressing CFMs per unit, which usually undersizes small systems and greatly oversizes large systems (Table 2).

Electric motors that run vacuum pumps are usually either 5, 7.5, 10, 15, or 20 HP and 1 HP motors will deliver 10 CFM ASME on an oil pump, or 7.5 CFM on a water pump. You must determine the pump size for your vacuum usage range (Table 3).

For determining the size of vacuum pump needed, include 30 CFM for running the system, 10 percent loss due to leaks, and 3 CFM per unit for each unit (2 CFM to milk and 1 CFM added for milk meters and other losses). This should provide more than adequate vacuum for most systems (Table 4). This does not include extra capacity for one half of the units open on the floor. A milking system should not be designed for poor milking procedures. Adequate milking vacuum level to prevent liner slip will reduce fall-offs and most automatic take offs will shut off automatically on fall-offs.

Milk Line Size

Most new systems installed in Florida will require a 3-inch milk line. Systems over a double 16 size may require a double looped milk line on each side of the parlor with a receiver jar for each side of the parlor. All milk lines should be looped and have at least 1 inch of slope per 10 feet of milk line.

Pulsator Line Size

A 3-inch diameter plastic pulsator line is used for rigidity and ease of taping for pulsators. There is no need for a size larger than 3 inches.

Table 1. Standards for milk lines

Units per slope	Milk line size diameter in inches
2	1.5
4	2.0
6	2.5
9	3.0

Table 2. Florida vacuum system requirements.

1. 30 CFM ASME to run the system.
2. 10% leakage in the system.
3. 3 CFM/unit, including milk meters and usage losses.

Pump HP	Oil Pumps*	Water Pumps*
5	50 -30 to run system - 5. leaks 15 for units÷3/unit = 5 units	38 -30 to run system - 4 leaks 4 for units ÷ 3/unit = 1 unit
7.5	75 -30 to run system - 7.5 leaks 37.5 for units ÷ 3/unit = 12 units	56 -30 to run system - 6 leaks 20 for units ÷ 3/unit = 6 units
10	100 -30 to run system -10 leaks 60 for units ÷ 3/unit = 20 units	75 -30 to run system - 7.5 leaks 37.5 for units ÷ 3/unit = 12 units
15	150 -30 to run system -15 leaks 105 for units ÷ 3/unit = 35 units	113 -30 to run system -11 leaks 72 for units ÷ 3/unit = 24 units
20	200 -30 to run system -20 leaks 150 for units ÷ 3/unit = 50 units	150 -30 to run system -15 leaks 105 for units ÷ 3/unit = 35 units

* Numbers expressed in CFMs unless otherwise stated.

Table 3. Pump horsepower and number of milk units.

HP	No. units with oil pumps	No, units with water pumps
5	1 - 5	1
7.5	6 - 12	2 - 6
10	13 - 20	7 - 12
15	21 - 35	13 - 24
20	36 - 50	25 - 35

Table 4. Parlor size and size of pump needed (one unit per stall).

Size of Parlor	Number of Units	Oil Pump HP	Water Pump HP
Double 6	12	7.5	10
Double 8	16	10	15
Double 10	20	10	15
Double 12	24	15	15
Double 16	32	15	20
Double 20	40	20	25
Double 30	60	25	30
Double 40	80	40	50

Table 5. Number of units possible per line size and slope.

Milk line size	Slope of line					
	0.5%	0.8%	1%	1.25%	1.5%	2%
	Number of units					
2 inch	2	3	3	4	4	5
2.5 inch	4	5	6	7	8	10
3 inch	6	9	10	13	16	24
4 inch	21	28	32	35	38	43