Mastitis is the most costly disease in the dairy industry, with the biggest loss from subclinical mastitis, when bacteria are already in the udder. These organisms destroy milk-secreting tissue and thus lower milk production.

Subclinical mastitis cannot be detected on a strip plate, but it is found through a high somatic cell count. A count of 1 million cells/ml indicates that over 30% of a herd's quarters are infected with mastitis.

Herds with high cell counts and many infected quarters will have losses in milk production and income in the range of 20-30%. A 500-cow dairy, averaging 50 pounds of milk per cow per day for 365 days a year, with a $16 per hundred pounds milk price that has a 20% loss would lose $292,000 a year because of mastitis (Table 1).

### Table 1. Estimated potential dollar losses caused by mastitis on a 500 cow dairy with high cell count.

<table>
<thead>
<tr>
<th>Loss</th>
<th>%</th>
<th>$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subclinical mastitis milk loss</td>
<td>73</td>
<td>213,160</td>
</tr>
<tr>
<td>Clinical mastitis losses, drug cost, dumped milk</td>
<td>22</td>
<td>62,240</td>
</tr>
<tr>
<td>and labor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Culling</td>
<td>5</td>
<td>14,600</td>
</tr>
<tr>
<td><strong>Total potential mastitis losses</strong></td>
<td></td>
<td><strong>$ 292,000</strong></td>
</tr>
</tbody>
</table>

### Anatomy of the Udder

The cow’s udder consists of four separate quarters containing a complex network of various sized ducts, blood vessels and capillaries, ligaments, and secretory tissue. Because milk is constantly being produced and is stored in the udder between milkings, it must be strong and well attached to the cow. In high producing cows, 60 pounds of milk may be stored in the udder between milkings.

### Udder Support System

The size and shape of the udder may vary considerably with the age and inheritance of the cow. Attachment of the udder to the cow is by elastic and nonelastic suspensory ligaments (Figure 1). The median suspensory ligament is located in the center of the udder and holds the udder up in the middle. The other inelastic set of ligaments on the outer walls of the udder are called the lateral suspensory ligaments and also aid in udder support.

![Figure 1. Udder support system.](image-url)
**Udder Divisions**

The udder is divided into halves by the central supporting ligament and each half into quarters by a fine membrane (Figure 2). While each quarter is separate and no transfer of milk occurs between quarters, antibiotics can be transferred from one quarter to others through the extensive blood network throughout the udder. This is the reason that a cow treated in one quarter with antibiotic must have milk from all quarters discarded, and antibiotics administered in the muscle or other areas of the body will end up in the milk through the blood supply system.

![Figure 2. Udder divisions.](image)

**Histology of the Mammary Gland**

**The Alveolus**

The alveolus is the basic component of secretory tissue. It is composed of epithelial cells that surround a cavity, the lumen. Milk constituents (protein, fat, lactose) are synthesized and secreted by the epithelial cells into the lumen of the alveolus.

The alveolus is surrounded by numerous muscle cells known as myoepithelial cells (Figure 3). These are activated by oxytocin and cause milk ejection from the lumen of the alveolus. Milk is ejected from the alveolus through the capillary milk duct which empties into a series of mammary (milk) ducts that get progressively larger until eventually the milk reaches the gland and teat cisterns. Myoepithelial cells also are found on smaller ducts in the mammary gland and aid in milk removal.

![Figure 3. An alveolus and its component parts.](image)

**Lobules and Lobes**

Groups of alveoli form lobules that are drained by a common duct. One lobule may contain 150–250 alveoli.

Lobules join together to form a lobe that is drained by a larger duct (Figure 4). As described previously these also connect to form still larger ducts which eventually reach the mammary gland cisterns and ultimately the teat cistern and streak canal as milk exits the gland.

![Figure 4. Mammary duct and lobule-alveolar systems.](image)
Teat Histology
The teat wall (Figure 5) contains an abundance of elastic connective tissue and two layers of muscle tissue (an inner layer of longitudinal muscles and an outer layer of circular muscles). The teat skin is covered with a normal squamous cell epithelium and is hairless. The teat or streak canal is lined with epithelium and has a particularly thick layer of flat cornified epithelial cells.

This albuminous layer of cells is frequently referred to as keratin. Keratin is vitally important in preventing the entrance of mastitis causing organisms into the mammary gland.

The Lymphatic System
Lymph is a colorless fluid drained from tissue spaces by thin walled vessels. These vessels have many one-way valves that allow lymph to move only in the direction of the lymph node (Figure 6).

The supramammary and other lymph nodes in the cow’s body are responsible for disease resistance by forming lymphocytes, which are a form of white blood cell involved in protection against diseases.

When a mastitis infection occurs, the lymph nodes increase their output of lymphocytes into the lymphatic vessels, which discharge them into the cow’s blood supply. Lymphocytes then travel to the udder to combat mastitis infection.

The Circulatory System
The flow of blood to the udder is very important for milk production since it requires about 500 volumes of blood to produce one volume of milk. A cow producing 100 pounds of milk a day will require as much as 6000 gallons of blood to circulate to the udder. The extensive circulatory system needed to transport blood to the udder is depicted in Figure 7.

The Milk Letdown Process
To harvest all the milk from the udder, you must have the cow’s cooperation. To achieve this cooperation, treat the cow properly, not only during the milking process, but also from the time the cow is moved to the milking area.
A cow lets down her milk if she is stimulated properly before milking. Since cows seem to be creatures of habit, this stimulation process need not be extensive but should be consistent. Stimulation can include washing or massaging the udder and forestripping milk out of each quarter. During stimulation nerve impulses cause the pituitary gland to discharge the hormone oxytocin into the blood system. Oxytocin then circulates in the blood to the udder and stimulates contraction of the myoepithelial cells surrounding the milk-filled alveoli. The milk is then forced into the duct system and into the gland and teat cisterns.

If the cow becomes excited or suffers pain either before or during the milking process, the cow’s cooperation stops. This excitement or pain causes release of epinephrine (adrenaline) from the adrenal gland into the blood stream. This reduces the blood and oxytocin supply to the udder and inhibits myoepithelial cell contraction and milk ejection (Figure 8). In order to remove as much milk as possible from the udder, it is very important to treat the cow in a routine and gentle manner, both before and during milking.

**MACHINE MILKING**

The milking machine usually applies 12.5 to 15 inches Hg (mercury) of vacuum to the outside of the teat. This produces a pressure differential of 12.5 to 15 inches Hg negative vacuum pressure on the outside of the teat compared with the 0.8 psi positive pressure inside the teat. This pressure differential is great enough to open the sphincter muscle and the milk is ejected, even at the end of milking when the internal pressure diminishes.

Since the vacuum applied forces milk out of the teat, it also forces blood and body fluids to the end of the teat. If a constant vacuum is applied to the teat, damage will occur. The pulsator and the double-chambered teat cups are designed to prevent this from happening (Figure 9).

**The Milk Removal Process**

There is a positive pressure inside the cow’s udder of about 0.4 pounds per square inch (psi) before the cow is stimulated; after stimulation the pressure increases to about 0.8 psi. The sphincter muscle at the end of the teat is tight enough to keep the milk inside, but if the muscle is not strong enough, milk will leak out even before the cow is stimulated.

**HAND MILKING**

The outside pressure on the teat is one atmosphere or 14.6 psi. The act of hand pressure and internal pressure forces open the sphincter muscle and the milk is removed.
Mastitis

Mastitis is the costliest disease of the dairy industry today. Losses are estimated to be as much as $200 per cow annually. It is obvious that dairymen must control this disease to achieve maximum profit from their enterprise.

As explained earlier, epithelial cells synthesize milk constituents (protein, fat, lactose). Mastitis is a bacterial infection and destroys these milk-secreting cells. Scar or connective tissue replaces the milk secreting tissue which results in a permanent loss of productive ability.

Mastitis organisms enter the udder through the teat end and streak canal. The streak canal is held closed by a circular muscle that holds milk in and foreign matter out, and is lined with keratin, which traps and kills organisms that attempt to invade through the teat end.

Mastitis-Causing Organisms

About 95% of all infections are caused by *Streptococcus agalactiae*, *Staphylococcus aureus*, *Streptococcus dysgalactiae*, *Streptococcus uberis*, and *Escherichia coli*. The other 5% are caused by other organisms.

CONTAGIOUS ORGANISMS

These are spread by hands, milking units, etc.

*S. agalactiae* lives in the udder and cannot exist outside the gland for long periods. It is susceptible to penicillin and, once eliminated, usually does not return to the herd unless infected cows are purchased.

*S. aureus* lives in the udder and on the skin surfaces of an infected cow. It can be controlled effectively with good management and is moderately susceptible to antibiotics when the infection first involves the gland, older infections usually do not respond to treatment. Severe cases may cause death.

*S. dysgalactiae* may live almost anywhere: in the udder, rumen, feces and in the barn. They can be controlled with proper sanitation and are moderately susceptible to antibiotics.

Mycoplasma is a unique organism. It does not fit the description of a bacterium or a virus and is classified as a microbe. Mycoplasmas do not have cell walls, leaving them unaffected by most antibiotics that interfere with cell-wall formation. Since no effective treatment is available, the best way to control this disease is to avoid purchasing cattle from known positive-tested herds. In addition, if cattle are routinely purchased, the bulk tank and pot herd milk should be sampled monthly. Mycoplasmas can be spread through the use of contaminated bottle mixes, syringes, and teat tubes in treating mastitis cows. Other infected cows are major sources of infection which can be transmitted by the milking machine components, hands of the operator, use of common rags and sponges, and directly from the environment. Teat dipping is essential for proper control.

The spread of contagious organisms are controlled by teat dipping and are eliminated by dry cow therapy. Herds with contagious mastitis problems usually have to get back to dip cups and cover the whole teat to the base of the udder to control the spread.

ENVIRONMENTAL ORGANISMS

These live in the cows’ environment and are always present.

Coliform bacteria are environmental pollution organisms; they live in feces, polluted water, and bedding material. Excellent sanitation is needed for their control. They are not susceptible to antibiotics.

*S. uberis* live most everywhere; in the rumen, feces and even in the udder. They can be controlled by proper sanitation and milking clean, dry udders.

When Do Infections Occur?

The rates of new infections are the highest during the first two weeks of the dry period and the last two weeks of the dry period. New infection rates are also high in early lactation and diminish as the lactation proceeds.

Infection Dynamics

To understand mastitis infection, you must realize how its level changes on a herd basis. New infections can be brought into the herd in four general ways: 1) new infections during lactation, 2) new infections during the dry period, 3) infected heifers entering the herd, and 4) infected cow purchases.

Infections are eliminated in four general ways: 1) spontaneous recovery, elimination by the animal’s own defense mechanism, 20% effective; 2) use of lactation therapy, usually 30-40% effective; 3) dry period therapy, usually 80-90% effective; and 4) culling the animals, very effective (100%).

Somatic Cells Described

Somatic means of the body. Thus, a somatic cell is simply a body cell. Examples are skin cells, muscle cells, bone
cells, or virtually any cell in the body. In milk, however, the predominant cell types are epithelial and white blood cells.

Epithelial cells of the alveoli are most numerous and active during early lactation when milk production is greatest. Throughout the cow’s lactation these cells slowly age and gradually are sloughed into the milk. Milk production drops during late lactation as these cells become fewer and less productive. While this is a dynamic process, the number of epithelial cells found in milk is relatively constant throughout lactation.

The other group of cells consistently found in milk are the infection-fighting cells of the body, the white blood cells. They always are present in the udder. However, in the presence of an inflammation they increase to tremendous numbers. Since inflammation generally results from infection, high somatic cell counts in milk are associated with mastitis.

Mastitis Control Practices

Proper Milking Procedures

Proper milking procedures are important for the prevention of mastitis and for insuring complete milk removal from the udder.

Mastitis can decrease total milk production by 15% to 20%. To minimize loss and achieve maximum milk yield, a practical milking management scheme should be followed.

The term milking management also includes care for the environment in which cows are housed or pastured. The dairy cow should have a clean dry environment. This helps reduce the potential for mastitis and increases milking efficiency by reducing time and labor to clean udders before the milking process.

MOVING COWS

Movement of cows should be in a quiet gentle manner. If cows are frightened or hurried, the milk letdown process may be disturbed. Therefore, rough handling of dairy cattle should be avoided.

MASTITIS DETECTION

Milking may begin with a check of all quarters for mastitis. It is acceptable to strip milk onto the floor in a milking parlor or flat barn. Any cows that show clinical mastitis should be examined and appropriate action taken. If fore milking is not done, visual checking for inflamed quarters is done by milkers and herd health people.
valve or milk hose clamp which prevents the backjetting of bacteria from one teat to another.

**Backflushing**

Backflushers have been developed to sanitize the liners and claws between milkings. Most units on the market have four or five cycles. The first cycle is a water rinse, followed by an iodine or similar sanitizer rinse, a clear water rinse, and positive air dry cycle.

Research has demonstrated that backflushers do reduce the number of bacteria on the liners between cows, but do not reduce the number of bacteria on teats. Backflushers also may stop the spread of contagious organisms, but this can also be accomplished at a much lower cost by teat dipping. There is no effect on environmental pathogens that are encountered between milkings.

Backflushers may be effective in stopping the spread of contagious mastitis; however, there is limited research to support this view. Because of the high initial cost, need for daily maintenance, and limited efficacy, backflushers are not routinely recommended.

**Post-milking Teat Dipping**

There is only one way to effectively stop the spread of mastitis in the dairy herd, and that is by applying teat dip to every quarter of every cow after every milking. Teat dips are used to remove milk residue left on the teat and kill organisms on the teat at the time of dipping. They also leave a residual film of sanitizer between milkings.

Are teat dips effective against all mastitis organisms? Yes, teat dips have been shown to effectively reduce mastitis caused by *S. areus* and *S. agalactia*, the most common types of mastitis found in Florida.

There seems to be much controversy about the effectiveness of teat dipping on environmental pathogens *E. coli* and *S. uberis*. Some research has shown that teat dipping does not control these organisms. These pathogens are found in the cow's surroundings; if there is udder-deep mud, the teat dip will be removed and a new infection may occur.

**TYPES OF TEAT DIPS**

There are many effective teat dips, including iodine at 0.1%, 0.5%, and 1.0%, and chlorhexidine at 0.5%. Also, although it is not labeled for teat dipping, hypochlorite at 4.0% with a sodium hydroxide content less than 0.05% was effective in field trials. There are many more teat dips on the market that are effective in preventing new infections. Effective coverage of the teats is more important than the type of dip being used.

**DIP OR SPRAY**

If contagious bacteria is present in your herd, *strep. ag.*, *strep. dysgalactiae, staph. areus*, or mycoplasma you must dip the whole teat to the base of the udder to stop the spread. Wand sprayers are acceptable for herds that have environmental mastitis, since teat colonization is not a factor. Hand-held spray bottles are almost worthless in getting proper coverage of dip on the cow’s teats, so they should not be used.

**Dry Cow Therapy**

Dry cow treatment is administered after the last milking of the cow before the dry period. Care must be taken to scrub the teat end with cotton and alcohol before infusion and to use teat dip after infusion.

There are many antibiotics available for dry cow therapy. High levels of penicillin and dihydrostreptomycin, the cloxacillins and other products specifically for dry treatment are effective.

The idea of dry period therapy has been accepted because antibiotics can be put into a slow release base that allows them to stay in the udder longer. They are not constantly being milked out of the udder as is the case with lactation therapy. Antibiotics can be administered in higher quantities because there is no concern for milk levels and antibiotic residues.

While dry treatment is very effective, it must be administered properly and the dry cows must have favorable environmental conditions. Teat ends must be scrubbed clean with cotton alcohol pads before injecting the dry treatment. If the teat ends are not cleaned properly, you may inject into the udder very high numbers of bacteria, which would overwhelm the antibiotic just administered. Unsanitary treatment procedures cause rather than eliminate mastitis.

Management of dry cows also is very important in mastitis control. If dry cows are exposed to muddy or dirty conditions, risks of mastitis will increase. This is especially true at the time of calving; cows are under much stress during this period and if an udder is exposed to wet dirty conditions, mastitis will increase. If you believe that your dry cow therapy program is ineffective, it may be because of poor treatment procedures and /or improper management of the cows during the dry period and at calving.
Culling

Culling cows for mastitis is effective in eliminating mastitis in the herd. Cows that have been treated many times in a single lactation are prime candidates for culling, as they may no longer be profitable because of discarded milk and antibiotic costs. It is usually more profitable to carry out preventive mastitis control procedures and cull only old chronic cows rather than to try and control mastitis by routine culling.

Summary

Mastitis is a very costly disease, but losses can be reduced greatly by following an effective control program, which should include the following items:

1. Handle cows gently to achieve highest production.
2. Follow proper milking procedures, milk clean, dry udders, apply milking units properly, and make adjustments to prevent the admittance of air into the teat cup liners and prevent liner slip.
3. Dip cow’s teats after milking to prevent new infections.
4. Treat all cows going dry with an approved dry cow drug in commercially prepared tubes to eliminate existing infections and prevent new infections during the dry period.
5. Cull chronically infected cows.

Milking Machine Factors

Research has demonstrated that “liner slip” is one area in which the milking machine may increase mastitis. This is when air is admitted through the top of the teat cup. Milk and bacteria, if present, may be propelled into the teat end of an adjacent teat, thus causing a new bacterial infection. Also, the use of malfunctioning pulsators can cause teat end damage and increase the rate of new infection.

The milking machine has little effect on mastitis if properly operated and functioning according to the manufacturer’s specifications. Clearly though, when operated improperly, milking machines can have a role, and malfunctioning equipment can cause mastitis in several ways. If the pulsator is dirty and does not function properly, this will cause the massage phase to be eliminated with the teat end being damaged. A vacuum controller that is dirty also will not function properly and again damage the teat end. Damage to this entry area for organisms increases the risk of mastitis.

Components of the Milking System

The Vacuum Pump

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.

Our recommendation for pump capacity is 30 CFM ASME to run the system plus 1.5 CFM/milker unit. This is a minimum and is for usable CFM, not pump CFM. This makes it very difficult to size a system since you must know the amount of leakage in the system before you start. Most systems in Florida have large enough vacuum pumps. If you are concerned that you don’t have enough vacuum, you might try checking for leaks. In Table 2, we see the capacity of systems found in the Florida survey.

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.

Table 2. Pump capacity - CFM/unit ASME at 15 inches Hg.

<table>
<thead>
<tr>
<th>CFM/unit</th>
<th>Number of herds</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;5</td>
<td>7</td>
</tr>
<tr>
<td>5 - 10</td>
<td>27</td>
</tr>
<tr>
<td>10+</td>
<td>5</td>
</tr>
</tbody>
</table>

Average CFM/unit = 7.5; range 3.5 - 13 CFM/unit.

In Table 3, we see that Florida dairies have more leakage in their systems than is desirable. Only two of the 39 dairies surveyed had systems which met the standard.

Table 3. Leaks in vacuum systems, CFM ASME.

<table>
<thead>
<tr>
<th>Percentage CFM leak</th>
<th>Number of herds</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;10</td>
<td>2</td>
</tr>
<tr>
<td>10–19</td>
<td>8</td>
</tr>
<tr>
<td>20–29</td>
<td>16</td>
</tr>
<tr>
<td>30–39</td>
<td>8</td>
</tr>
<tr>
<td>40–49</td>
<td>1</td>
</tr>
<tr>
<td>50+</td>
<td>3</td>
</tr>
</tbody>
</table>

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

Table 4 describes usable CFM’s per unit, or pump capacity minus leakage. This is the vacuum available for milking.

Table 4. Usable CFM/unit, measured at the receiver jar.

<table>
<thead>
<tr>
<th>CFM/unit</th>
<th>Number of herds</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;5</td>
<td>17</td>
</tr>
<tr>
<td>5–10</td>
<td>22</td>
</tr>
<tr>
<td>10+</td>
<td>0</td>
</tr>
</tbody>
</table>

Average usable CFM/unit = 5.6; range 2.5–9.5 CFM/unit.

Thus, on the average, Florida dairies had 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**

1. Check belts - replace if worn or oil-covered, and keep tight.

2. Keep the motor clean.

3. If you have an oil reclaimer, clean the filter.

4. 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. This may even burn the pump up if it doesn't get enough water.

5. Check balance tank. The drain on bottom should seal off. If old and rusty, replace it.

**SUMMARY**

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 responds 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.

**TYPES 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 it 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.

CHECKING THE RESPONSE OF THE CONTROLLER
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
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.

SUMMARY
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. Maintenance 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. These are most common in Florida.
- 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.

**SUMMARY**

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.

**LINER SHAPES**

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.

Equation 1 shows the formula for determining number of days to use liners:

\[
\text{Liner life} \times \text{no. of units} \times \text{Times/day} \times \text{milking} \times \text{no. cows in herd} = \text{no. of days}
\]

Equation 1.

For example (Equation 2), using liners with a 1200 milking life, 20 units, twice a day milking, and 500 cows:

\[
\frac{1200 \times 20}{2 \times 500} = 24 \text{ days of liner life}
\]

Equation 2.

Because of the large number of cows milked in Florida, it usually is more labor efficient to leave the liners on the units until it is time to discard them, rather than going to all the trouble of dismantling them each week and resting them for a week. This works fine up north where the dairyman milks 30 cows with three units two times per day.
LINER VENTS AND CLAW VENTS
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.

TYPES OF 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.

SUMMARY
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 14-15 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” 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, Vacuum Lines, Pulsator 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**

There is still much confusion over milk line size. The 3A standards listed in Table 5 are probably not relevant. Carrying capacity is influenced greatly by the slope of the line. A 1.5% slope is probably the most effective. To determine if you have adequate line size, measure the vacuum in the milk line. If it does not vary by more than 0.6” Hg, it’s adequate.

**Table 5. 3A standard for milk lines.**

<table>
<thead>
<tr>
<th>Units per slope</th>
<th>Milk line size (diameter in inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>1.5</td>
</tr>
<tr>
<td>4</td>
<td>2.0</td>
</tr>
<tr>
<td>6</td>
<td>2.5</td>
</tr>
<tr>
<td>9</td>
<td>3.0</td>
</tr>
</tbody>
</table>

**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 40-50 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.

**SUMMARY**

Today’s modern milking systems should be designed so that all components are compatible. The main vacuum line should be looped and have 1–1.5 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 and Optional Equipment**

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 (ATOs)**

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.

**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 in-lets connected 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.
Summary
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. 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.

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

Next, wash the system for 8–10 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 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.

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°F and 110°F.

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.

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

Every 6 Months
1. Monthly cleaning as usual.
2. Replace all pulsator rubber parts.
3. Replace all pulsator hoses, air tubes.

4. Replace receiver jar gasket.

5. Replace all milk hoses.

6. Replace rubber hoses and rubber hose nozzles used to wash udders (rubber hoses harbor bacteria).

7. Flush pulsator and vacuum lines.

8. Check belts on vacuum pumps.

**Yearly**

1. Do monthly and 6-month cleaning as usual.

2. Replace all wash line hoses.

3. Replace trap gasket.

4. Replace wash manifold cups.

5. Replace belts on vacuum pump.

**Spray Voltage and Mastitis**

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 2.5mA (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, reducing 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.

**Summary**

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 a fact sheet that gives more detail on this subject.

**Sizing the Milking System**

**Vacuum Requirements**

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.

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.

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) (see Table 6, Table 7, and Table 8). This should provide more than adequate vacuum for most systems. 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 Lines Size

The following are excerpts from the National Mastitis Council annual meeting proceedings, 1993 (see Table 9).

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.

Trouble Shooting a Problem Herd

Since mastitis can be caused by man, machine, and the cow’s environment, all items must be checked to determine its cause.

What is a mastitis problem herd? Any herd that continually has a cell count above 400,000 cells/ml can be considered a problem. But herds that have a cell count of nearly 1 million cells/ml, and are close to losing their market, are usually considered a problem.
Variations in Clinical Mastitis

The number of cows or quarters treated for clinical mastitis can vary from herd to herd even though they may have identical mastitis occurrence. The time or season of the year also may be a factor. An average of 1%–3% of the cows in the pot herd (per day) over a year’s time is probably typical for a Florida herd.

An increase or decrease in the number of clinical mastitis cases may result from a change in the people doing the milking. If the milkers stop checking for clinical mastitis, the number will decrease. If no one had been checking for clinical mastitis and suddenly started checking, the number of cases would increase dramatically even though nothing had changed in the mastitis level of the herd. In many herds, number of cases increases during hot, muddy conditions when environmental organisms are the cause.

Do you have a herd mastitis problem, or just a few cows with a mastitis problem? By recording cows treated during one consecutive month and comparing them with the cows treated in the previous month, you can determine if the same cows are being treated over and over again. If so, you may consider removing those cows from the herd.

STAGE OF LACTATION AND MASTITIS

If most new cases of mastitis occur at calving, you should review your dry cow program by asking yourself these three questions: 1) are all cows dry treated with an approved dry cow antibiotic? 2) are teat ends cleaned with cotton and alcohol before treatment? and 3) are dry cows kept in a clean dry environment and allowed to calve in a clean dry place?

PROBLEM SOLVING WHEN CELL COUNT RANGE IS 400,000-750,000 CELLS/ML

1. Clean pulsators.

2. Clean vacuum controllers.

3. Check milking procedures. Are you milking clean, dry udders and shutting off vacuum to the claw before removing the unit?

4. Check teat dipping procedures. After milking, is there any visible dip on the teats? In problem herds, teat must be dipped with a cup not sprayed - dip to base of udder.

5. Review your dry cow program. Are all quarters dry treated before going dry?

PROBLEM SOLVING WHEN CELL COUNTS ARE ABOVE 750,000 CELLS/ML

1. Follow procedures 1-5 above.

2. You are in danger of losing your milk market; you may wish to use the paddle test or use individual cow cell counts to identify high count cows. Late lactation pregnant cows can be dried off early. You may wish to cull late lactation cows that are not pregnant. If this does not lower your cell count enough to sell milk, more drastic measures must be taken. Treating all the high cell count cows will usually lower the cell count but, because of the high cost of drugs and dumped milk, it will be very expensive.

3. Consult your veterinarian, county agent, or sanitarian for further help. Your county agent also has other fact sheets available on mastitis and checking milking equipment.

How to Handle Mycoplasma Problem Herds

You only know if you have mycoplasma if you sample for it. Since it’s untreatable, you should prevent it, or at least prevent the spread of it.

NO SAMPLE APPROACH

- Teat dip to stop the spread from cow to cow during milking.
- Use only commercial tubs - use no bottle mixes to treat intramammary.
- Mycoplasma cows usually exhibit the following symptoms:
  - More than one quarter with clinical mastitis.
  - This mastitis does not clear up with treatment and the cow does not show any signs of sickness.
  - Drop in milk production.

Table 9. Number of units per slope. *

<table>
<thead>
<tr>
<th>Milk line size</th>
<th>0.5</th>
<th>0.8</th>
<th>1.0</th>
<th>1.25</th>
<th>1.5</th>
<th>2.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 inches</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>2.5 inches</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>3 inches</td>
<td>6</td>
<td>9</td>
<td>10</td>
<td>13</td>
<td>16</td>
<td>24</td>
</tr>
<tr>
<td>4 inches b</td>
<td>21</td>
<td>28</td>
<td>32</td>
<td>35</td>
<td>38</td>
<td>43</td>
</tr>
</tbody>
</table>

*Parlor, with units attached every 10 seconds per slope. Peak flowrate = (12lb/min)/cow. Steady air admission = (0.35-0.7 scfm)/unit. Transient air admission = (3.5 scfm)/slope

bNumber per 4” line may vary with number of operations.

Parlor, with units attached every 10 seconds per slope.
• If you routinely cull the above type animals, mycoplasma will come and go and you will never know it. It won’t spread if you do a good job of teat dipping and no bottle mixes are used.

SIMPLE SAMPLE APPROACHES
• Regular bulk tank analysis.
• When mycoplasma appears:
  • Make sure you are doing a good job of teat dipping and use no bottle mixes.
  • Cull cows: multiple quarters with clinical mastitis that don’t clear, and cows that seem healthy.
  • If records are kept of animals entering milking string, the animals since the last bulk tank sample can be sampled. This approach usually will take care of these problems.

FULL SCALE SAMPLES
• Expensive.
• Great care in sampling - rubber gloves, sanitized between cows or you will spread from sample bottle to sample bottle, and think you have an epidemic when you only have a couple of cows infected.
• Epidemics usually happen by spreading from cow to cow using bottle mixes. If you have an epidemic and use bottle mixes, review your pot herd records - these are your mycoplasma cows.

WHAT NOT TO DO IN A MYCOPLASMA CRISIS
• Panic.
• Sample the whole herd (expensive).
• Rinse milkers with water.
• Buy backflushers.
• Try to separate (unless you have 100’s). This usually changes milking routines and causes many other problems, and it is not effective anyway.

Trouble Shooting a Herd with a High Bacteria Count
High bacteria counts usually are caused by poor cleaning of milking equipment or improper cooling of the milk and herds with *strep. agalactia*.

1. Check hot water temperature during the rinse cycle, it should be cool, not hot. Rinse water should be discarded.

2. Check hot water temperature in the wash sink at the start of wash-up. It should be 160 and 110-120 degrees Fahrenheit at the end of the wash cycle.