How Does the Milking Machine Work?
Pulsation – Massage and Milking Phase

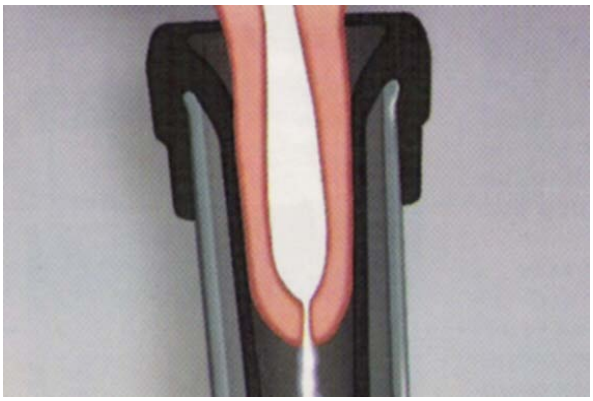
Many people that milk cows do not completely understand how the milking machine works. A better understanding of the milking machine can help workers pay attention to equipment problems and respond more quickly to factors that can affect worker, cow, and/or equipment function during milking.

The pulsator is the heartbeat of the milking unit. You hear it during milking. You can also feel pulsation if you put your finger into the teat cup when the milking system is turned on. Pulsation is the opening and closing of the inflation around the teat. If you had a transparent teat cup, you could see the inflation (e.g., liner) open and close. Since most teat cups on commercial dairies are stainless steel, you generally will not see the inflation open and close. However, milking technicians should be trained to listen for the sound of properly working pulsators as each cow is milked.

Why is pulsation important?

Vacuum removes air from the pulse chamber of the teat cup. By applying vacuum to the teat end, the teat canal is opened and milk is removed from the quarter. This vacuum is important but it also can have a negative impact. When the teat is exposed to vacuum, blood and lymph are moved into the teat, causing it to buildup and the teat to swell. A little bit of congestion (buildup) does not cause damage to the teat. However, if the teat is exposed to vacuum for very long (e.g., 5 to 10 minutes at a time, and 2 or 3 times per day), it stresses the teat, is painful for the cow, and will lead to permanent teat damage. Teat damage is a concern on dairies because it increases the risk of a cow developing mastitis. Red, blue, or purple teats after milking are a signal that pulsators or the vacuum system is malfunctioning. Increased mastitis rates can also be a signal that pulsators and or vacuum level have improper settings.

The milk phase or the time period when the inflation is open causes milk to be harvested but also leads to blood and fluid congestion. A rest period is necessary to relieve buildup of blood and lymph.

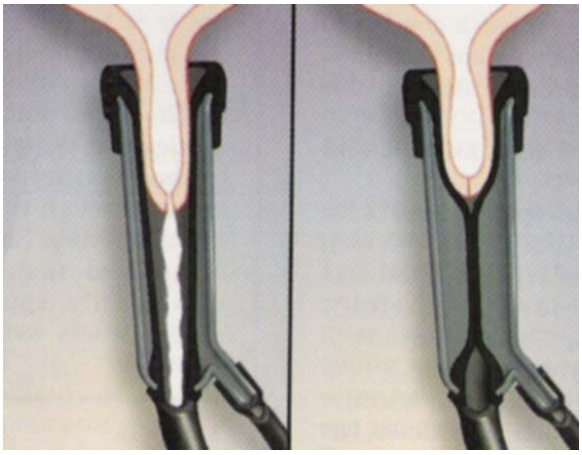


Picture Source: Pierre Levesque, Institute of Ag Technology, Quebec, Canada.

Why is massage important?

Pulsation is necessary to remove milk from teats as well as to relieve congestion or swelling in the teat. During the *milk phase*, the inflation is open, and milk flows through the teat canal into the milking system. When congestion begins, the teat swells, the pressure starts to close the teat end, and milk flow decreases slightly. At this time, the massage phase becomes important to proper milking. During the massage or rest phase, the inflation collapses, putting pressure on the teat end and causing the teat canal to close. This stops milk flow for a short time period and more importantly sends blood and lymph back up the teat, relieving negative pressure on the teat and teat end. The massage phase is essential to maintaining health of the teat. After the short massage phase, the milk phase begins again. The inflation opens and milk is harvested from the udder.

Most pulsators are set so that there are 60 cycles per minute. Some others are set to 45, 50, 55, or 65 cycles per minute. During the one second of a pulse cycle, the inflation is open (milk phase) during half or a little more than one-half of this time. This is known as the pulse chamber ratio. When this ratio is 50:50, the milk and rest (massage) phases are about equal. They each last about 50% of one cycle. In other words, the inflation will be open for 430 milliseconds and closed for 400 milliseconds within each second of milking.



Picture Source: Pierre Levesque, Institute of Ag Technology, Quebec, Canada.

The milk phase (left) is the time period when the inflation is fully open and milk is harvested.

The rest phase (right) is the time period when the inflation closes almost completely, the teat is massaged and congestion is reduced.

The more time in the milk phase during each cycle, the faster the milking speed. However, the risk of teat congestion and mastitis will also be higher. In order for a 70:30 inflation chamber ratio to work effectively, both the milking procedure and equipment maintenance must be excellent so that teat end damage and new infection risk during milking are minimized.

How do pulsators work?

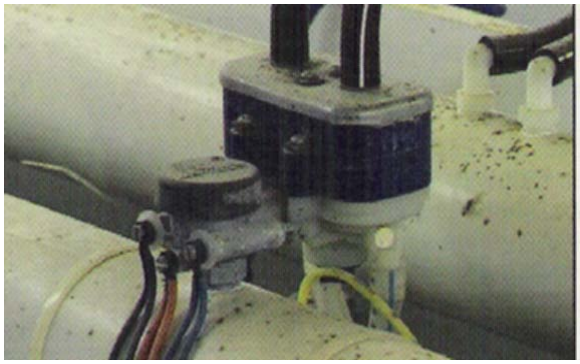
Pulsator action takes place in the teatcup and inflation. This opening and closing of the wall of the inflation around the teat is controlled by pulsators. The pulsator admits air (at atmospheric pressure) into the pulsator hose and then into the pulse chamber of each teat cup according to the time schedule described above. This air causes the inflation to collapse

or close around the teat. After a fraction of a second, vacuum is admitted into the pulse chamber (air is removed). This causes the inflation to open, the teat canal to open, and milk to be harvested from the gland.

Most pulsators are electromagnetic. This means they run off of an electric signal that sends current to a magnet. These electromagnets then activate a plunger to either let air at atmospheric pressure, or vacuum to withdraw air, into the pulsator hose. A control device is located either inside of each pulsator or within a panel box in the equipment or milk room.

Most pulsators are set to alternating rather than simultaneous action. This means the teatcups work in pairs. Two teatcups will be in the milking phase while the other two will be in the rest or massage phase. This keeps milk flowing continually from every cow. Depending on how the pulsator is set up, milk may be flowing from both rear quarters while the front quarters are at rest. This is called front to back pulsation. Alternatively, milk may be flowing from the right front and right rear quarters while the left quarters are at rest. This is called side to side or alternating pulsation. Older pulsators were often simultaneously controlled, meaning all teatcups were milking or at rest at the same time.

The pulsator controls pulsation by admitting air at atmospheric pressure into the pulsator hose and pulse chamber to close the inflation (rest phase). It also stops air entry based on a set time, allowing vacuum to be brought back into the pulse chamber, causing the inflation to open and milk to be harvested.



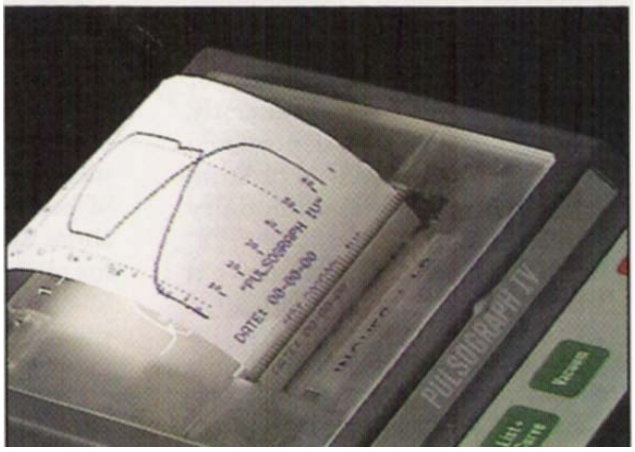
Picture Source: Pierre Levesque, Institute of Ag Technology, Quebec, Canada.

Maintenance of pulsators

Proper pulsator function is critical for maintaining healthy teats and reducing the risk of new infections during milking. Proper function is also important to maximize speed of milking. Because of the importance of proper function, pulsators must be checked on a regular basis. Milking consultants or equipment dealers have system analyzers which can be used to evaluate pulsator function. The analyzer will graph and report both pulsation rate and pulse chamber ratio for each pulsator. Regular analysis of system pulsation will help to identify small problems before they become major problems that seriously and permanently impact teat condition. If a pulsator is malfunctioning, the consultant or dealer will then check the pulsator for cleanliness and wear and repair or replace the pulsator unit. Pulsator hoses should also be checked to make sure they are not blocked, pinched, or worn. Faulty pulsator hoses will impact pulsation function and may lead to permanent teat damage. Have your udder health consultant check pulsators at least 1-time per year. To reduce risk of mastitis even more, and depending on number of milkings and cows, consider having pulsators checked every 6 months.

System analyzers, like the one shown here, are used to graph and print pulsator ratio and rates. If the consultant or dealer finds a problem with a pulsator they will troubleshoot the pulsator for cleanliness and parts wear. Pulsator hoses should also be checked to make sure they are not pinched or worn.

Pulsator hoses should be checked routinely by the producer and milkers for wear. Pulsators should be checked at least once a year for wear.



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