

Tissue Congestion Relief Product Design Specification

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Function: The current design of automated milking machines relies on a strong vacuum force to extract milk from the sinus udder. As a side effect, blood and interstitial fluids collect in the teat causing tissue congestion and at times, chronic edema. Tissue congestion in cows is not only uncomfortable, but can also lead to canal constriction causing reduced milking speed, bacterial infection, and hyperkeratinization. The newly designed milking machine attachment must extract milk at a comparable rate while simultaneously providing compression of the teat to better reduce tissue congestion.

Client requirements:

- Comparable milking rates
- Measurably reduce congestion

Design requirements:

- Machine and process must be sterile
- Weight must not exceed 2.3 kg total
- No chemicals may leach into milk
- Simple, repetitive technology must be intuitive and convenient for dairy farmers
- An addition to existing machines is ideal to minimize cost
- Must be comfortable for cow

1. Physical and Operational Characteristics

a. *Performance requirements:* The milking process is a manual process in which the claw and teat cups will be placed on each cow by hand. The milking machine will be used on a daily basis; each cow is milked at a minimum of twice a day, however, the machine will be used on different cows during the day. The number of cows each machine is responsible for milking varies with herd size. The inner and outer liners of the teat cups are under constant pressure from the outside; the machine varies between atmospheric and vacuum pressure. The vacuum pressure applied by the machine must remain constant throughout the entire milking process. The milking process takes approximately 4 to 5 min.

b. *Safety:* The device must be sanitized between uses due to its use on different cows. Warnings for proper use and/or instructions should be applied in order to reduce device malfunction, human accidents, and cow discomfort.

c. *Accuracy and Reliability:* Precision is necessary between alternating pressures. When alternating between vacuum and atmospheric pressure, the levels must remain nearly the same between cycles; vacuum pressure must remain between 32

and 40 kPa.

Constant pressure must be maintained throughout the entire milking process, approximately 4 to 5 min, and in each of the 4 teat cups. Low teat-end vacuum can result in liner slips and unit fall-offs. Constant and accurate pressure ensures and efficient and short milking period, as well as minimizes cow discomfort.

d. *Life in Service*: Milking unit used at least twice a day per cow (herd size can vary widely from farm to farm). The inner liner should last for approximately 1,200 milkings; the outer liner will last far longer.

e. *Shelf Life*: The attachment should be stored in a barn, away from weather conditions. The liner of the attachment may need to be replaced after it has shown considerable wear and no longer holds the teat properly. The other parts of the attachment should be durable, and should not need replacement unless they break.

f. *Operating Environment*: The device will be used inside of a milking parlor. It may be subjected to cold and humid temperatures, depending on location and weather. It will also be exposed to dirt and dust from the parlor and should be cleaned regularly.

g. *Ergonomics*: The vacuum of the milking attachment should be between 32 and 42 kPa. The device should not use a vacuum that exceeds 42 kPa because this could cause severe tissue congestion in the cow's teat. The pulsation rate should be 55 to 60 cycles/min and the pulsator on: off ratio should be in the range of 60:40 to 55:60.

h. *Size*: The size of the device should be similar to conventional milking attachments used today (between 0.9 and 1.8 kg) If the device is too heavy, a stronger vacuum would need to be used to keep it on the cow, and this could cause tissue congestion and well as add extra strain on the teat. There should be adequate space in the milking parlor to store the device.

i. *Weight*: Existing teat cups weight approximately 0.9 to 1.8 kg each. No minimum weight requirement exists. However, finding suitable materials to reduce this weight would be difficult and unnecessary. Granted, a lighter cup could use less suction to stay on the teat, but farmers will not sacrifice milking speed for lower suction.

Running along the same lines, a heavier teat cup would require more suction to stay on, which would cause more tissue congestion.

j. *Materials*: The liner is made of a given flexible plastic with varying shape and thickness. Different liners vary in specifications, but they all share the same principle of being flexible and shapely to accommodate the form of the teat. The

shell is made of hard metal, which allows atmospheric pressure to enter between the interior of the shell and the exterior of the liner.

The materials used must maintain the milk quality and flow rate while avoiding skin or tissue reactions (allergic or infectious) on the teat.

k. *Aesthetics, Appearance, and Finish*: The machine need not look “pretty” or satisfy any aesthetic requirements whatsoever. Its shape, however, should allow for ease of grip by the farmer so he or she may slip the cups on as quickly and efficiently as possible.

2. Production Characteristics

a. *Quantity*: One prototype needed.

b. *Target Product Cost*: Budget is undetermined at this point, however, due to the number of milking machines per farm, cost cannot be extremely high.

3. Miscellaneous

a. *Standards and Specifications*: Our new device must meet and/or exceed the standards of the current milking machine.

b. *Customer*: The user will be dairy farmers who would like to minimize tissue congestion and discomfort in cows while maintaining a high milking rate. Concepts and ideas may be taken from this project and used in human patients to relive tissue congestion.

c. *Patient-related concerns*: At this time, no concerns beyond those of the standard and widely accepted milking machine have been posed. Our project introduces no new cow/user related concerns.

d. *Competition*: There have been many attempts to improve the standard milking machine, yet none have prevailed to date. Many ideas fix one problem, but leave other issues unaddressed or even worsen them.