Teatcup liners: where the rubber meets the teat

1. Introduction

A teatcup liner is defined in International Standards terminology as "a flexible sleeve having a mouthpiece, a barrel and an integral or separate short milk tube" (see diagram). The liner is the only component of the milking machine that comes into contact with the cow's teat. Therefore, the liner is THE KEY component in the process of milking cows quickly, gently and completely. This Quick Note provides basic information to help farmers choose and use liners that will improve milk harvesting on their farm. The time and money spent in careful selection and maintenance of the right liners is almost always a cost-effective investment.

2. Interpretation and relevance to Australian conditions

In theory, liners of all types are designed to:

- provide an airtight seal at both ends of the shell;
- provide a mouthpiece and barrel of a size that will fit a range of teat shapes and sizes, thereby minimising liner slips and cluster falls;
- milk out as quickly and completely as possible, minimising teat congestion, discomfort, and injury; and
- clean easily.

In practice, however, liner design is often a series of compromises or trade-offs between competing goals. For example, a liner designed primarily to reduce cup slips tends to be less comfortable for cows. A liner designed primarily for fast milking tends to leave more milk behind as 'strippings milk' trapped in the udder.

3. Relationship to CowTime goals

Liner design and action greatly affect milking productivity and cow comfort. The results of many comparative experiments indicate that liner design usually has a greater effect on milking characteristics than any other machine factor. Six-fold differences in strippings yield, eight-fold differences in the incidence of teatcup slips, and 33% differences in milking times between liner types are evident in the results of comparative studies in Ireland, for example. Properly functioning liners minimise teat damage and so encourage good cow behaviour and calm milking.

4. Selected features of liners and some of their effects on milking characteristics

Amongst the hundreds of designs available throughout the world, the diameter of the mouthpiece lip ranges from 18-26 mm, the mid-bore of the liner barrel from 18-30mm, and the effective length of the liner from about 90-164mm. Small changes in material properties of liners, or changes of only 1 or 2mm in their physical dimensions, have a remarkably large influence on their milking characteristics (see diagram showing the main parts of a liner).

Rubber type and composition

Liners are made of natural, synthetic (usually nitrile) or silicone rubber. These properties affect the useful working life of a liner, measured in 'cow-milkings'. Countdown Farm Guidelines, page 36, shows how to calculate liner life in 'cow-milkings'. Liners made of natural rubber are good for 600-800 cow-milkings, whereas most Australian liners made of nitrile rubber or natural/nitrile blends can be used for 2500 cow-milkings or 4-6 months, whichever comes sooner. Although silicone rubber liners are more expensive initially, they last longer. Individual manufacturer's claims vary from 3000-5000 cow-milkings (or 4-6 months, whichever comes sooner); or 1500 working hours; or up to 10,000 cow-milkings, presumably depending on the type of silicone used.

Method of construction

Liners may be made in either 1 or 2-piece designs. A 2-piece liner has a separate short milk tube. Most Australian farmers choose 1-piece moulded liners, mainly because they are easier to assemble and simpler to change when due for replacement.

Barrel size

Liners are commonly described as either wide, medium or narrow-bore depending on their internal diameter relative to the average teat size for a given herd. Thus, a wide-bore liner has a bore (measured 75mm below the

mouthpiece lip) that is at least 1 mm larger than the mean teat diameter measured at the mid-point of the teats. A narrow-bore liner has a bore that is at least 2mm smaller than the mean mid-teat diameter of the herd. Measurements made in a few Australian herds in the late 1970s and early 1980s indicated that the average teat diameter, measured at its mid-point just before milking but after milk letdown, was about 23.5mm. If those old data still provide a valid general guideline for Australian herds, then liners with a mid-barrel size less than 21.5mm would be described as narrow-bore, those between 21.5-24.5mm would be described as medium-bore, while those greater than 24.5mm are wide-bore liners.

According to the results of a separate research study, a mid-barrel size of about 22mm would allow cows in most Australian herds to be milked quickly, gently and completely. Other things being equal, increasing this mid-barrel size by 1 or 2mm would result in:

- fewer teatcup slips and falls (except on tight-uddered, small-teated cows);
- but higher strip yields, because the liner rides higher on the teat; and
- increased teat congestion and oedema (which implies less cow comfort).

Increasing the barrel bore diameter with respect to the mouthpiece lip diameter, or increasing the bore of the upper end of the liner barrel, or increasing the height of the mouthpiece chamber (between the liner lip and the 'throat' of the liner), all have similar effects to those listed above.

Liner length

The recommended effective length (EL) depends on the range of teat sizes in a herd, and on the liner bore. Wide-bore liners need a longer EL because the teat penetrates further into a wider bore liner. The minimum EL of liners made from natural or synthetic rubber should be; 135mm for liners with 21-22mm bore at mid-barrel; 140mm for liners of 23-24mm bore; 145mm for a mid-bore of 25mm or more. AMMTA technicians have access to tables showing the effective lengths of different commercial liners and how to measure the effective length.

This brief and incomplete description should serve to illustrate the complexities and subtleties of liner properties as well as the necessity for making compromises between competing benefits when selecting liners. A farmer whose main goal is to maximise cow comfort and completeness of milking, for example, should choose a narrow-bore liner with a small mouthpiece chamber and having a mouthpiece lip diameter about the same size as the mid-barrel bore. Another farmer, whose main goal is to reduce the incidence of liner slips and cup falling, might prefer a different design or type that has either a larger mid-bore and/or a smaller mouthpiece lip diameter relative to the barrel bore size and/or a bigger mouthpiece chamber.

5. Potential challenges with implementation

Replacing old liners

Both the internal surface finish and the milking performance of liners tend to deteriorate quickly at or soon after they reach the end of their designated use-by date. Although many people try to squeeze a few more weeks or months from the old liners, this is almost always a poor option for the most important component of the milking machine. As a general rule of thumb, if you notice a distinct improvement in milking performance after replacing the old liners, you probably have used the old ones too long. When renewing liners, always change all four liners within a cluster to maintain similar mounting tension and milking characteristics between the four teatcups.

Changing to a different type of liner

A key issue is to ensure correct matching between liners and teatcup shells. Most milking equipment companies provide guidelines for correct matching of their own particular brands. Most technicians also have access to a collated set of AMMTA specifications from different companies.

6. Robustness of this information

As outlined in the Countdown Farm Guidelines for Mastitis Control (Guideline 6), the five best and most practical ways to evaluate or to monitor the milking performance of teatcup liners involve systematic measurement or observation of:

- number of slips or falls, requiring action by milking staff, per 100 cows milked;
- average milking time per cow;
- average strip yields per cow or, preferably, the proportion of quarters with high strip yields (more than 100 mL/quarter);
- teat condition of a representative sample of cows in the herd; or
- cow behaviour

7. References and further reading

Readers wanting more information could contact any milking machine technician, veterinarian or dairy adviser who has participated in one of the Countdown Adviser Short Courses (see listing on Countdown website http://www.countdown.org.au)

AMMTA Milking Machine Specifications Handbook, 2001 (which is available via consultation with any milking machine technician who is a current member of AMMTA).

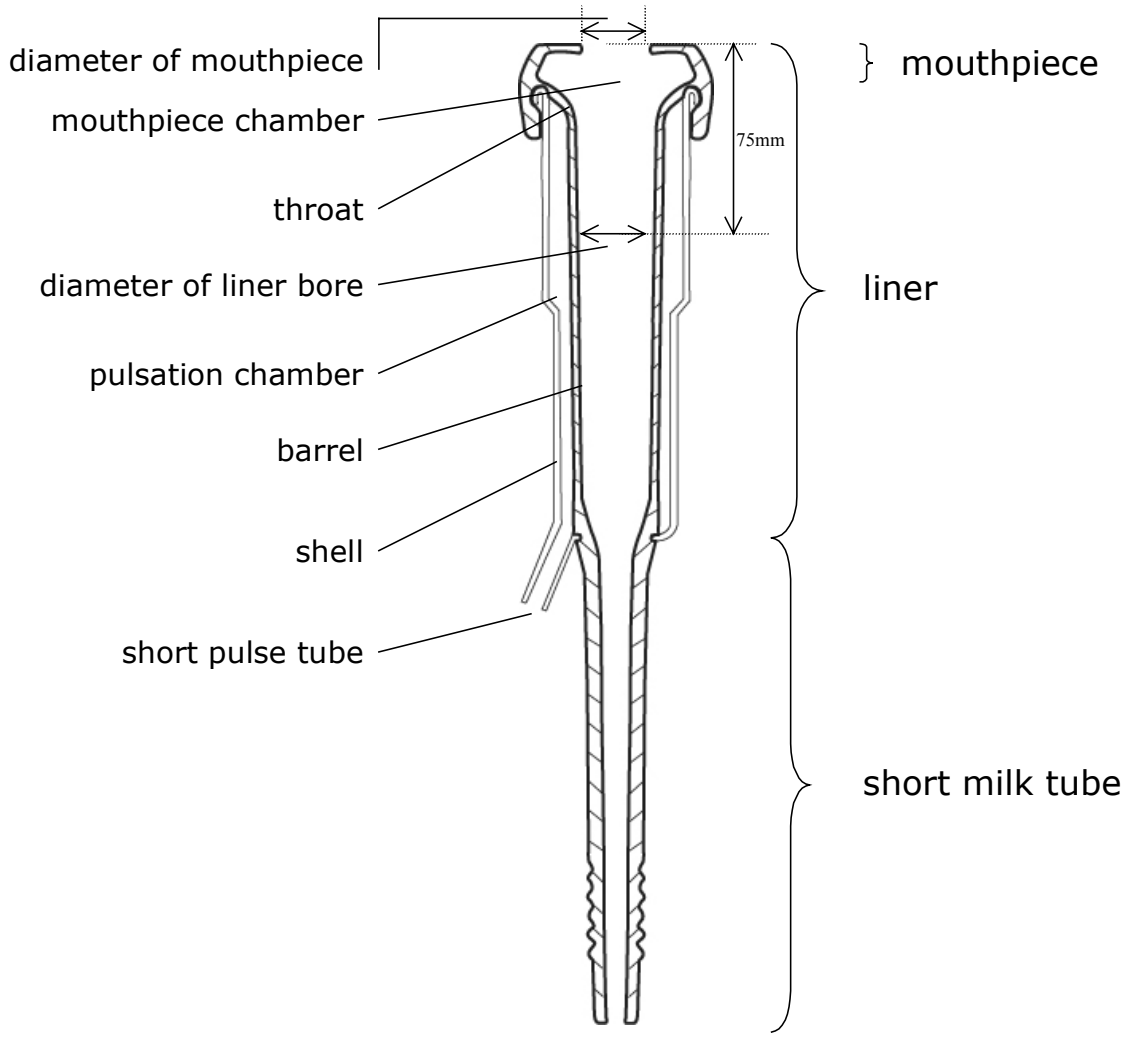
Brightling et al. (1998) Countdown Downunder Farm Guidelines for Mastitis Control (Guideline 6, pages 31-36), Dairy Research and Development Corporation, 3/84 William St., Melbourne, 3000.

Mein, G.A. (1992) Action of the cluster during milking. Chapter 4 in "Machine Milking and Lactation" edited by AJ Bramley, FH Dodd, GA Mein and JA Bramley, Insight Books, Burlington, VT, USA

CowTime Guidelines for milk harvesting - Chapter 5, edited by Klindworth, D. et al (2003). Available on the CowTime website www.cowtime.com.au

Quick Note 3.2: Checklist for making changes to milk harvesting infrastructure

Figure: Anatomy of a teatcup



Source: National Milk Harvesting Centre