



How can I tell if the liners need changing?

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

The liner is the only component of the milking machine that comes into direct contact with the cow’s teat. Therefore, it is the *key* component in the process of milking cows quickly, gently and completely. The observations that can be used by advisers and farmers to help evaluate the milking performance of liners are outlined in Guideline 6 of the *Countdown Downunder Farm Guidelines for Mastitis Control*. The five milking-time observations are described in detail in the revised Technote 6.1 and the revised Technote 13 (February 2003). They involve systematic measurement or observation of the:

- average milking time per cow;
- frequency of liner slips and cup falls requiring action by the milker;
- amount of ‘available’ milk left in the quarters of an udder when cups are removed;
- teat condition score of a representative sample of cows immediately before and after milking; and
- cow behaviour.

When the milking performance of the liners is suboptimal, it is necessary to determine whether:

- the existing liners need to be replaced; or
- the type of liner used needs to be changed.

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. Qualified milking machine technicians also have access to a collated set of specifications from different companies.

Confidence – High

The time and money spent in careful selection and maintenance of the right liners is almost always a cost-effective investment.

Research priority – High

A clearer, simpler set of physical guidelines to indicate when liners have reached their ‘use-by’ date would be helpful.

When renewing liners, always change all four liners within a cluster to maintain similar mounting tension and milking characteristics between the four teatcups.



As a general rule of thumb, if you notice an improvement in milking performance after replacing liners, the old ones were used for too long!



Technote 6.3 describes why some liners deteriorate more quickly than expected or have aged before milking their first cow.

The gradual change in liner length could be recorded at regular intervals and used as one of several practical indicators of when it is time to replace liners. The gradual change in mouthpiece deflection could be another good indicator of the remaining working life of most commercial liners.



Replacing old liners

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.

Liners are made of natural, synthetic (usually nitrile) or silicone rubber. Their composition affects their useful working life, measured in 'cow-milkings', because the physical shape, tension and surface condition changes gradually with liner use, age and storage. This gradual deterioration can have subtle but significant effects on their milking characteristics.

The *Countdown Downunder Farm Guidelines for Mastitis Control* shows how to calculate liner life in 'cow-milkings'. Liners made of natural rubber have a working life of about 600-800 cow-milkings, whereas most Australian liners made of nitrile rubber or natural/nitrile blends can be used for 2,500 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 3,000-5,000 cow-milkings (or 4-6 months, whichever comes sooner); or 1,500 working hours; or up to 10,000 cow-milkings, presumably depending on the type of silicone used.

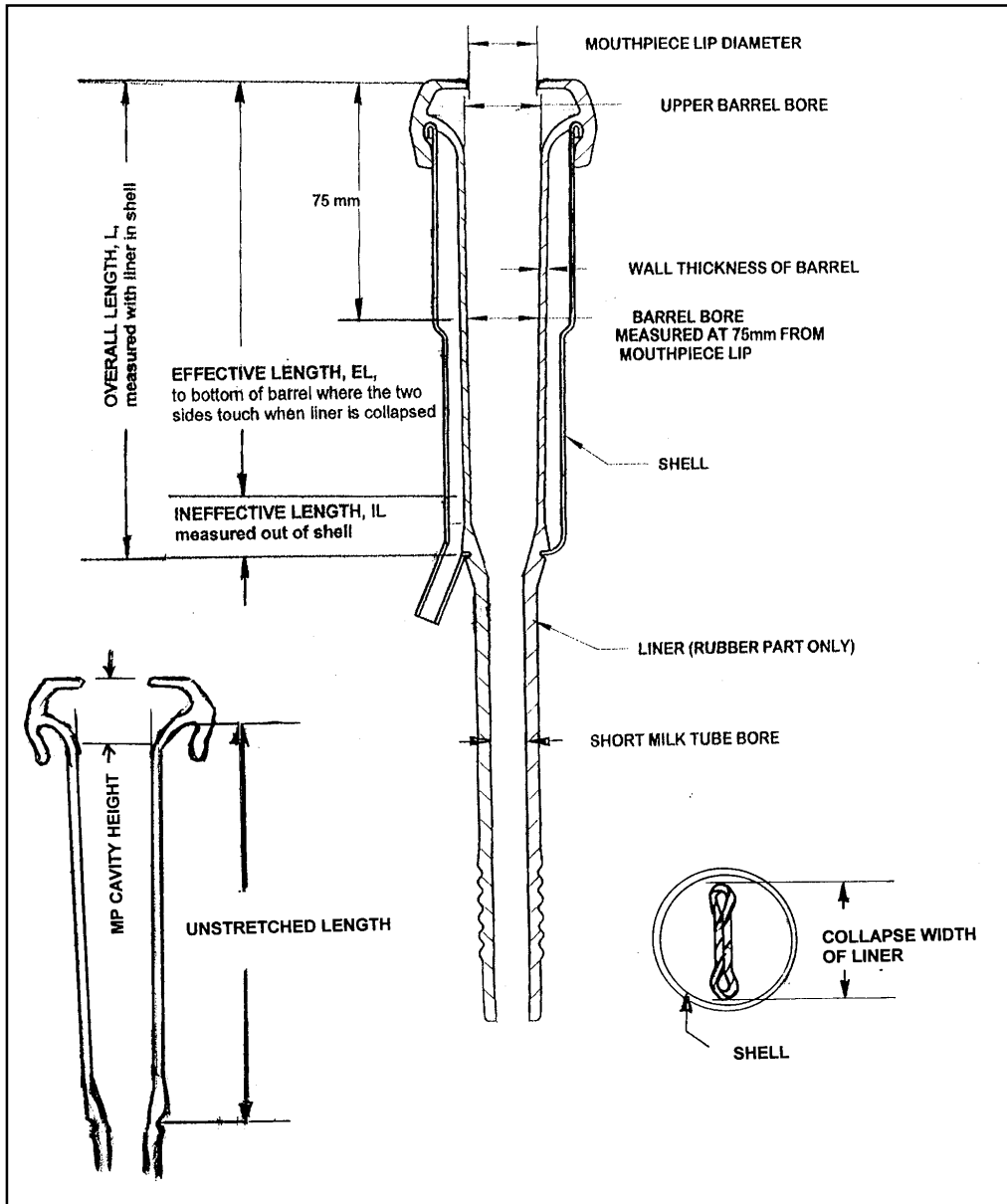
Both the internal surface finish and the milking performance of liners tend to deteriorate more quickly at or soon after they reach their designated use-by date.

All types of commercial liners are mounted under tension in their teatcup shells because the distance between the designed support parts of the liner is shorter than the shell length. Although the elongation of some highly stretched liners is almost 30% when they are new, most new liners are stretched (elongated) by 5-15% when they are mounted in their correct shells.

Liner barrels stretch gradually and therefore lose tension as they age. The change in length of a liner, relative to the length of a new liner of the same type, is one of the best indicators of the rate at which liners are wearing out. The unstretched liner length can be measured as the distance between the points at the upper and lower ends of the liner where it is supported or held by the shell (see the diagram opposite for an explanation of terms used for characterising teatcup liners). Then, the percent liner stretch can be calculated as:

$$\frac{\text{shell length minus unstretched liner length}}{\text{unstretched liner length}} \times 100$$

Some important dimensions and terms used for characterising a teatcup liner



Changing to a different type of liner

The results of many experiments indicate that liner design has a greater effect on milking characteristics than any other machine factor. Comparative studies in Ireland showed 6-fold differences in strippings yield, 8-fold differences in the incidence of teatcup slips, and 33% differences in milking times between liner types. Comfortable liners minimise the risk of teat damage and encourage better cow behaviour.

If the milking-time observations indicate that a change to a different type of liner may be beneficial, there are some basic principles that may be used in association with field experience to suggest possible alternative liners.

In theory, liners of all types are designed to:

- 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; and
- milk as quickly and completely as possible, minimising teat congestion, discomfort and injury; and
- clean easily.

In practice, 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' trapped in the udder cisterns.

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

Barrel size

Liners are commonly described as 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 75 millimetres below the mouthpiece lip) that is at least one millimetre 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 two millimetres 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 let-down, was about 23.5 millimetres. If those old data still provide a valid general guideline for Australian herds, then liners with a mid-barrel size:

- less than 21.5 millimetres can be described as narrow-bore
- between 21.5-24.5 millimetres would be described as medium-bore
- greater than 24.5 millimetres would be described as wide-bore liners.

Liners

According to the results of a separate research study in 1984 (Williams 1984), a mid-barrel size of about 22 millimetres 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 2 millimetres would result in:

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

Similar effects to the three listed above are associated with any of the following changes in physical dimensions of liners:

- increasing the barrel diameter with respect to the mouthpiece lip diameter;
- increasing the bore of the upper end of the liner barrel; and
- increasing the height of the mouthpiece cavity (measured between the liner lip and the upper barrel of the liner, this varies from about 18 millimetres up to 33 millimetres).

These generalisations should be interpreted with caution, however, because it is often difficult to separate effects that are mutually interdependent.

Tapering of the liner barrel reduces the frequency of teatcup slips and falls, perhaps partly because tapered liners tend to 'fit' a wider range of teat sizes and shapes. In most liner types, the upper-barrel is 1-2 millimetres wider than the mid-bore. In some highly tapered liner types, however, the difference is as much as 3-4 millimetres.

Liner length

The recommended effective length depends on the range of teat sizes in a herd, and on the liner bore. Wide-bore liners need a longer effective length because the teat penetrates further into a wider bore liner. Qualified milking machine technicians have access to tables listing the effective lengths of different commercial liners. Minimum effective lengths of liners made from natural or synthetic rubber should be:

- 135 millimetres for liners with 21-22 millimetres bore at mid-barrel
- 140 millimetres for a mid-bore of 23-24 millimetres
- 145 millimetres for a mid-bore of 25 millimetres or more.

Stiffness of liner mouthpiece lip

One technique used in liner design for reducing the frequency of liner squawks and cup slips is to stiffen the mouthpiece lip by making it slightly thicker. Various devices are used to measure mouthpiece deflection (often called 'stiffness' or the opposite term, 'mouthpiece softness').

It is important to remember that different compositions of the rubber used to manufacture liners will also have an effect on the actual milking performance of liners of similar physical dimensions.

A combination of field experience and observed changes in milking performance is used to determine if a change in liners is likely to be, or has been, beneficial.

Key papers

AMMTA Milking Machine Specifications Handbook, 2001. (Available to current members of the Australian Milking Machine Trade Association).

Mein GA. Action of the cluster during milking. In: Bramley AJ, Dodd FH, Mein GA, Bramley JA editors. *Machine Milking and Lactation*, Chapter 4, Insight Books, Vermont, United States, 1992:97-140.

Williams DMD. A study of the epithelium of the bovine teat canal. PhD thesis, The University of Melbourne, Australia, 1984.