Vacuum levels in the milking parlour: how high should you go?

How hard can it be to just milk a cow with a machine? It would seem to be a rather simple process as all you need is a liner, a claw, some pipes and hoses and of course a bit of vacuum. Prep the cow and place the cluster on with the teats properly inserted in the liners and then stand back and watch the milk flow, the udder empty and detach the cluster as the flow ends.

by Bill Gehm, CoPulsation, Lisle, New York, USA. www.copulsation.com

You may ask yourself what can possibly go wrong and then you realise that not all cows milk well or at the same speed and many have one or more quarters that either do not milk out or take much longer than others. Adding to the confusion is the fact that most heifers all start out milking rather well on day one and then a few months later you are dealing with problems and sorting cows.

What did nature intend?

There are a number of contributors to these issues with vacuum at the foundation of general milking performance. The vacuum levels used in the industry have a rather large range with many claims supporting either low or high vacuum levels. To best address the question of ideal vacuum level one should first consider what does the cow really need and what did nature intend with the calf?

Prior research conducted at the National Animal Disease Laboratory in Ames Iowa by J. S. McDonald and D. A. Witzel explored the vacuum and associated pressure differentials across the teat end of a cow while a calf was suckling. That research offers some valuable insight into the question of what vacuum level is required and reasonable to milk a herd of cows.

That research involved the insertion of catheters into the teat sinus with the catheter entering through a hole created in the side of udder and then directed down the teat ending just above the teat canal. Another catheter was firmly secured along the exterior of the teat tissue ending near the teat end to permit direct pressure measurements on either side of the teat canal. Fig. 1 provides a diagram of the catheter locations. These catheters provided a means of directly measuring both the vacuum created by a calf while suckling with that vacuum applied to the teat end and also a means of measuring the pressure within the teat sinus created by the compressive suckling action of the calf's tongue.

A calf extracts milk with a process that is different from that of a milking machine. A calf creates a total pressure difference across the teat canal that is a combination of:

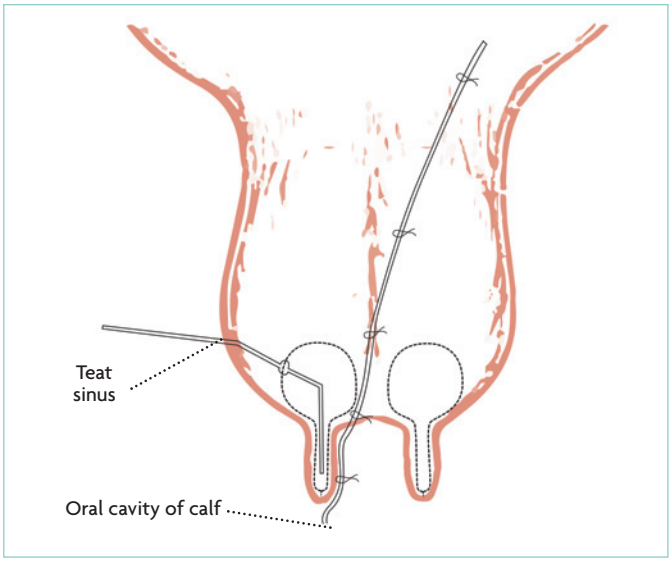

Fig. 1. Diagram of the catheter locations.

- A vacuum from the sucking action.
- A pressure created by compressing the teat between the tongue and roof of the mouth.

The resulting average total differential pressure of 71 kPa (21inHg) is considerably higher than machine milking and allows the flow of milk from the teat sinus into the mouth of the hungry calf. The contribution from vacuum alone ranged from 30kPa to 54kPa from easy to hard milking cows.

The data from the research determined that both the vacuum and the applied compressive pressure can vary depending on the physical characteristics of the teat being suckled. Basically, some teats milk more easily than others. That is a fact commonly observed when milking cows as anyone who has ever milked a cow knows that some teats will flow milk with a very light touch, while others take a rather firm grip. Those differences result in the range of total pressures required to milk a herd of cows. Another study of hand milking reported a pressure in the 54-81kPa range applied to the teat wall during hand milking with

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Fig. 2. Mastitis data showing a downward trend following an increase in vacuum level.

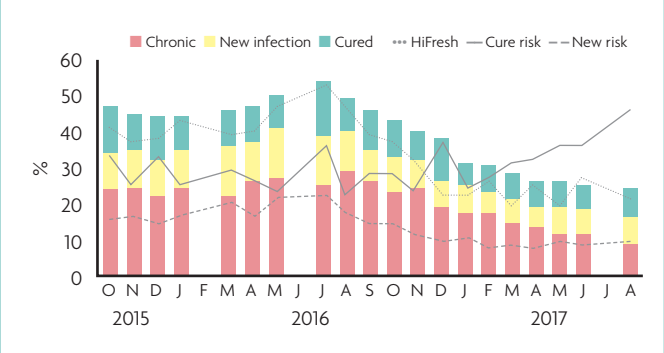
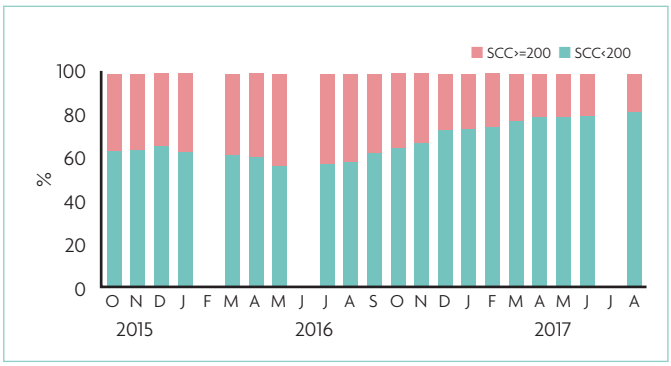


Fig. 3. The associated improvement in the percentage of cows with an SCC under 200,000.



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one hard-milking cow requiring 101kPa.

It was also noted that the vacuum applied by a calf on the teat end went to zero during the rest phase. It is also important to recognise the fact that vacuum was not applied to the length of the teat, as a milking machine does, but rather the teat is cradled between the tongue and roof cavity. The calf provides more of a massage than just a harsh vacuum pull.

The cumulative research of pressure required to milk cows both by hand and with nature's milker, the calf, shows that high pressure can be required therefore vacuum levels with milking machines are actually rather low when below 51kPa.

Higher vacuum levels

The LR Gehm company has engaged a large number of dairy farmers to milk cows at vacuum levels of 54-60kPa to determine what benefits might exist when milking closer to the pressure differences created by a suckling calf. The data from an 1800 cow dairy milked at 56kPa (16.5inHg) for over a year was compared to prior data with the herd milked at a more typical industry level of 46kPa.

The results on that farm show much higher milk flow rates, less time spent milking and reductions in mastitis with the higher vacuum. Auto-detacher settings were also adjusted to provide a detach at a flow rate of around 2lb/minute (1kg/min) which aligns with research by Ralph Ginsburg of the Israel Dairy Board.

Mastitis data for this herd is provided in Fig. 2 and shows a downward trend in mastitis rates following the increase in vacuum level. The data in Fig. 3 shows the associated improvement in the percentage of cows with an SCC under 200,000. Machine on time was reduced as the parlour turn times decreased in a double 20 herringbone.

Other commercial herds have participated in this effort operating at vacuum levels as high as 60kPa with similar results. The higher vacuum levels are more similar to the study that determined an average pressure difference of 71kPa is delivered by a suckling calf.

Some very important aspects of operating a milking system at higher vacuum levels must be considered to ensure that the teat is properly rested during the rest phase and that the cluster is detached in a timely manner. A calf reduces the vacuum to zero during the rest phase and the teat is fully compressed/massaged by the tongue. This suggests that the resting action of the milking system must provide proper relief from the milking vacuum to avoid teat tissue stress/harm.

A failure to reduce vacuum on the teat canal during the rest phase and a failure to properly massage the full length of the teat in a gentle manner for an appropriate duration will cause problems. Use your finger to evaluate the liner action of your milking system to see how well it matches that provided by the calf.

It is fair to conclude that some cows can be milked well at lower vacuum levels. The challenge is that many cows simply will not milk well at vacuum levels below 50kPa with many requiring 55kPa or more. Observing cows during milking will readily tell you which ones struggle to milk out well at lower vacuum. Note the uneven udders and slow milking quarters and try milking those cows by hand. Compare the results and ask yourself if your vacuum levels and milking system are providing the milking action nature intended.

A well-designed milking system will permit all cows to milk very quickly leaving healthy teats that are not swollen or milk-wetted upon machine removal. This requires a vacuum level high enough to ensure proper milking of all cows in the herd, not just the easy ones. Rest action on the teat must ensure the teat canal and full length of the teat are relieved from the vacuum for a sufficient duration of time. Milking units must be removed as flow is ending and excess weight and downward pulling of units must be avoided as research has shown that these cause unnecessary teat stress.

If there remains doubt about getting a problem cow to milk with a milking machine, simply attach a hungry calf and observe how fast the udder empties. ■

You can see a video of cows milking at the 1800 cow dairy in Wisconsin, USA, with 16.5inHg at https://www.youtube.com/user/copulsation

Another dairy milking at an even higher level is in the Netherlands milking at 18inHg. You can see those cows milking at https://www.youtube.com/watch?v=ezNoMCb_-FA

References are available from the author on request