BENEFITS FROM EARLY REMOVAL OF THE MILKING UNIT

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SUMMARY

The milking unit can be detached at a milk flow rate of 400 g/min without having a negative effect on milk yield. Machine-on time is shortened and teat condition improved, and udder health does not seem to be affected. The threshold may be set even higher for cows milked more than twice daily. It is recommended that specific setting of switch points and delay times are evaluated for each farm. A good pre-milking teat preparation, a short, consistent interval until attachment, and calm cows are prerequisites for detachment at high flow rates. Cows will respond with reduced machine-on times, improved teat condition, and complete milking out.

INTRODUCTION

End of milking flow rate based detachers are used worldwide. Most of the new milking parlours are installed with automatic cluster removers (ACR) and it has become very common to use ACR in stanchion barns as well. The first portable ACR were very heavy, but as electronics have improved, ACR units have became lighter and more advanced. Today it is possible to buy ACR computer linked equipment that will give an estimate of machine-on time, milk flow, and milk yield. The claimed advantages of ACR are no over-milking, improved teat condition, labour saving, and a more consistent milking routine. Disadvantages include cost, maintenance, and reliability. The list of requirements of ACR is long and includes: reliable and handy, correct measurement of milk flow rate at end of milking, delay until detachment, adjustable switch point and delay time, initial delay time in the beginning of milking, closure and relief of vacuum before detachment but without drop of the milking unit, minimal influence on milking vacuum, no negative influence on milk quality and udder health, and a test procedure provided.

Traditionally, the cow has been regarded sufficiently milked when the milk flow rate drops below 200 g/min. However, it is still an open question whether this threshold is the best or not. Removal of clusters at higher flow rates will leave more milk in the udder but shortens the machine-on time whereas low threshold values may increase over-milking for the faster milking quarters.

This paper deals with different settings of thresholds and their influence on machine-on time, milk yield, and udder health. Threshold is used as a general term for milk flow rate at detachment whereas switch point is the flow rate at which the delay time until detachment is initiated.
THE INFLUENCE OF OVERMILKING ON TEAT CONDITION AND UDDER HEALTH

Hillerton et al. (1) observed poor teat condition in herds with over-milking. The effects were assessed by scoring teat colour, response to touch, ringing at the base of the teat, and degree of teat orifice closure. Teat colour and ringing at the base of the teat evaluated immediately after detachment showed the biggest differences between types of milking systems. However, effects were confounded with liner type, cluster, and milking system. The interaction between cluster type and over-milking was investigated in a Latin-square design (2). About one third of teats was reddish even with no over-milking but the proportion increased with 2 and 5 min of over-milking. Certain types of liners caused more ringing at the base of the teat and ringing after over-milking with these liners were more pronounced. It was concluded that avoidance of over-milking is especially important with certain milking conditions (2). It appears that as vacuum level increases and massage provided to teats during milking is reduced, the negative effects of over-milking become more pronounced. Lack of massage may be due to selection of a wrong liner for that size of teats, stiff liners, or pulsation failure. The influence of over-milking on udder health has been evaluated at several occasions. However if over-milking is associated with mastitis its effects appear to be small (3). Reverse pressure gradients across the teat canal might be related to bacterial invasion of the teat cistern. Reverse pressure gradients occur only during milking on empty teats (4) and over-milking will therefore increase the possibility for bacteria to enter the teat by this method. On average, front teats will start over-milking at a threshold value of 400 g/min and rear teats at 200 g/min (Rasmussen, unpublished data).

WHAT IS THE TRUE THRESHOLD?

Initiation of detachment at a particular milk flow rate (e.g. 200 g/min) does not ensure that the milk flow rate is that when the milking unit is detached. Apart from the switch point, the actual flow rate at removal of the milking unit depends on the final delay time and the rate of decrease in milk flow towards the end of milking. A long final delay time will cause over-milking for cows with a rapid decrease in flow rate at end of milking. Conversely, actual milk flow rate at removal of the milking unit will be less influenced by the final delay time for cows with a slow flow rate decrease. When different ACR were tested a difference in machine-on time of 1.5 min occurred between a flow rate decrease of 0.15 and 0.60 kg/min (5). It appears that there is no relationship between chosen switch points of ACR and time of removal of the milking unit (5). Consequently, the switch point indicates the highest milk flow rate that would initiate removal of the milking unit.

There is no International Standards (ISO) test procedure for ACR that will give the correct switch points and delay times or formulas to apply to specific set-ups. Some of the difficulties that interfere with tests are: measuring technique, measuring point in respect to ACR sensors, milk or artificial test fluid, length of hoses, lifting height, and pulsating or continuous flow. Stated threshold values for different types of ACR often differ and what is a threshold of 300 g/min for one type of ACR is not necessarily the same for another type. Delay time is probably the most variable factor among types of ACR because different systems use different parameters and sensors such as electronic measurements, counts of slugs, or mechanical devices. A 10 s delay time for one type of ACR might equate to 2 s for another type. Consequently, changes in switch points and delay times have to be evaluated on each farm.
EXPERIMENTS WITH CHANGES IN SWITCH POINT AND DELAY TIME

There are very few reports on the influence of ACR on milking performance and udder health and only one in a reviewed journal. Threshold values of 200 and 400 g/min were tested in a change over experiment with 16 cows (6). The threshold value of 400 g/min compared with 200 g/min reduced the machine-on time by 0.68 min per day and had no significant effect on milk yield, but increased the amount of milk that could be milked out after automatic cluster removal. Long term studies are still needed to evaluate the influence on udder health.

Rasmussen (7) reported an experiment with 135 freshly calved cows that were split into two treatments. Group 200 cows were milked with an ACR switch point of 200 g/min and a delay time of 18 s. Group 400 cows were milked with an ACR switch point of 400 g/min and a delay time of 12 s. Treatments started four days after calving and lasted 36 weeks for first lactation cows and 12 weeks for older cows. Cows were milked in stanchion barns with high pipeline milking. The main results are shown in Table 1.

Table 1. Milking performance and udder health of cows with automatic cluster removers detaching the cluster at threshold values of 200 or 400 g/min

<table>
<thead>
<tr>
<th>Group</th>
<th>First lactation</th>
<th>Older cows</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>200</td>
<td>400</td>
<td>200</td>
</tr>
<tr>
<td>No. of cows</td>
<td>38</td>
<td>33</td>
<td>32</td>
</tr>
<tr>
<td>Machine-on time, min</td>
<td>5.54*</td>
<td>5.01</td>
<td>7.90*</td>
</tr>
<tr>
<td>Energy corr. milk, kg</td>
<td>22.78</td>
<td>22.73</td>
<td>33.26</td>
</tr>
<tr>
<td>Teat end eversion, %</td>
<td>39*</td>
<td>25</td>
<td>67*</td>
</tr>
<tr>
<td>Teat thickness front, %</td>
<td>3.4</td>
<td>2.3</td>
<td>0.7</td>
</tr>
<tr>
<td>Teat thickness rear, %</td>
<td>5.5*</td>
<td>1.1</td>
<td>-0.8</td>
</tr>
<tr>
<td>Cell count, log</td>
<td>4.94</td>
<td>4.84</td>
<td>5.11</td>
</tr>
<tr>
<td>Clinical mastitis per 100 cow days</td>
<td>0.17</td>
<td>0.25</td>
<td>0.75</td>
</tr>
<tr>
<td>Cows sub-clinically infected, %</td>
<td>37.0</td>
<td>45.7</td>
<td>40.3</td>
</tr>
<tr>
<td>Cows sub-clinically newly inf., %</td>
<td>16.4</td>
<td>15.3</td>
<td>15.0</td>
</tr>
</tbody>
</table>

* Significantly different from value of Group 400: P < 0.05.

Overall, machine-on time was reduced by 0.52 min (P< 0.05) by increasing the threshold from 200 to 400 g/min. The reduction in machine-on time seemed to be consistent throughout the lactation. Peak milk flow rate was not increased and average milk flow rate of Group 400 cows was slightly higher than of Group 200 cows. Milk yield and treatment group did not influence milk composition. Hind quarters normally have higher milk yield and take longer time to milk than fore quarters; consequently, the reduction in machine-on time of Group 400 could have reduced the proportion of milk in hind quarters, but no such change was detected. Significant differences in scores for teat end hyperkeratosis were established after only four weeks of milking of older cows and after eight weeks of milking of first lactation cows. These differences between treatment groups clearly demonstrate that the last 0.5 min of milking when teats are getting empty of milk is a sensitive period for developing hyperkeratosis. Teat end thickness increased during milking for hind teats of first lactation cows in Group 200 compared with Group 400. The same trend was observed in fore teats, but there was no significant difference in teat end thickness for older cows, although the trend seemed to be reversed. There was no difference in cell counts between the two groups. There was no difference between groups in the number of clinical cases of mastitis of first lactation.
cows or in the sub-clinical udder health status of cows. Older cows of Group 200 developed more clinical cases than Group 400 but this difference was not significant. Percent quarters sub-clinically infected during lactation were 7.4% and 9.5% and the new infection rates 4.2% and 5.8% in Group 200 and Group 400 respectively for cows not having sub-clinical or clinical infections during the first 10 days after calving. These differences were not significant. Those cows that had an infection in the early stage of lactation had 23.1 and 23.5% infected quarters compared with new infection rates of 11.7% and 7.2% (P<0.05) in Group 200 and 400 respectively. It was concluded that the milking unit could be detached at a milk flow rate of 400 g/min instead of 200 g/min without having negative influence on milk yield. Machine-on time is shortened and teat condition improved, and udder health does not seem to be affected (7).

THRESHOLD VALUES WHEN MILKING MORE THAN TWICE DAILY

Lactation milk yield was increased by 14% and 15% by giving cows access to be milked 3 or 4 times daily respectively (8). Machine-on time increased with 40 and 56% and significantly disrupted the teat ends as lactation advanced. Obviously, milking occurred on teats not full of milk. It was concluded that more attention should be paid to the milking conditions with more frequent milking. Hyperkeratosis of the teat orifice is a consequence of too much vacuum for too long a time and too a short time to recover after milking. By not attaching the milking unit when milk will not flow and removing the milking unit at a relatively high flow rate at the end of milking, the influence of milking vacuum on the teat tissue will be minimised. In a short term experiment a switch point of 400 g/min. was not sufficient to improve teat condition of cows milked four times a day but the time period (four weeks) might have been too short (9).

Early removal of the milking unit seems to be a possibility for shortening the machine-on time and preserving teat condition. High switch points of automatic cluster removers function as soon as the initial delay time is passed. Consequently, the milking unit is removed if the flow rate is lower than the pre-set switch point. In the experiment of Ipema and Benders (8) average milk flow rate was just above 1.1 kg/min. in late stage of lactation of cows milked 4 times a day. Only half of those cows would have had a chance to be milked to any extent if the switch point was set to 1 kg/min. The question remains whether the cows could be trained to deliver their milk within a short period of milking.

High threshold values are only practicable if milk flows continuously shortly after attachment. Consequently, cows must be pre-stimulated and milk ejection evoked before attachment of the milking unit. Oxytocin is released as long as milking continues and causes no discomfort to the cow. With twice daily milking pre-stimulation may be responsible for less than 5% of milk yield, whereas release of oxytocin during milking may enable extraction of more than 95% of available milk. A shorter machine-on time shortens the period of oxytocin release. It is not known if this could actually improve the oxytocin release of four times daily milking.

AMERICAN EXPERIENCES WITH HIGH THRESHOLD VALUES OF COWS MILKED 3 TIMES DAILY

The threshold value of automatic cluster removers might be set higher than 400 g/min for cows milked more frequently. An increase of the threshold value to 1.0 kg per min reduced machine-on time but did not reduce milk yield of high producing cows being milked 3 times per day. Setting of the threshold value to 0.5 kg/min for the whole herd did not influence milk yield either (Paetz, personal communication).
Two farms with three daily milkings were studied when the threshold of ACR was increased (10). Herd 1 milked 430 cows in a 2x12 herringbone parlour. The switch point was increased from 300 to 450 g/min and the delay time decreased from 12 to 7 s. Machine-on time decreased from 7.8 to 6.4 min and milk production increased slightly from 39 to 40 kg per cow per day. Managers of the herd reported that they could easily milk at least 70 more cows with the same labour cost at the new ACR settings. Herd 2 milked more than 700 cows in a 2x10 herringbone parlour. The switch point was increased stepwise from 200 to 900 g/min and the delay time decreased from 15 to 3 s. Machine-on time decreased from 7.4 to 6.2 min and milk production increased from 34 to 37 kg per cow per day. A random sample of fresh and mid to late lactation cows showed less than 100 g of milk left in all four quarters after detachment. Both dairies reported less stepping and kicking of the cows in the parlour, especially of first lactation cows, with earlier detachment.

These American field reports show successful application of early detachment of the milking unit for cows milked three times daily. The reported increases in milk yield are probably confounded with change of other factors as well but shows that the potential is there to harvest the milk in less time.

CISTERNAL CAPACITY AND MILK YIELD

The milk yield increase by milking three times a day compared with twice is reported to be 5-25%. The increase in milk yield is a response of 1) removal of the feed back inhibitor (FIL), 2) increased cell differentiation, and 3) an increase in the number of cells. First lactation cows respond in terms of percentage better to more frequent milking than older cows. Moreover, cows bred for low milk yield increased milk yield more with three daily milkings than do cows bred for high milk yields (11). The percentage of cisternal capacity might well explain why cows react differently to better milking. First lactation cows have lower cisternal capacity than older cows, and the cisternal capacity of first lactation cows increases (or at least maintains) during lactation whereas older cows decrease their capacity (12). Cows with low cisternal capacity are more sensitive to inadequate milking conditions than cows with a higher percentage, and this might explain why first lactation cows respond better to 3 daily milkings than older cows.

In a more frequent milking experiment where cows were selected for milk yield it was suggested that there has been a parallel selection of cows with a low and a high percentage of cisternal capacity respectively (11). Cows with a higher proportion of cisternal capacity are more efficient milk producers because the feed back inhibitor is active in alveolar milk only. An overall selection of cows with high milk yields and a relatively high percentage of cisternal capacity might also explain why cows 30 years ago increased milk yield with good pre-stimulation but do not today. Consequently, there is less influence of milk left as strip yield on milk production of a modern high producing dairy cow. In a half-udder experiment with moderate producing East-German cows milk yield increased by 7% in the first lactation in the udder half where machine stripping was performed and by up to 11% in the fourth lactation (13). Incomplete milking with twice daily milkings decreased milk yield even of goats with a high proportion of cisternal milk (14). Deliberately under-milking causes loss of milk yield but this phenomenon should not be confused with high settings of threshold values where cows are used to this method. If the amount of cisternal milk left after an early removal of the milking unit is less than the storage capacity of the milk lobes and cisterns, milk will not be forced back in to the alveoli as the milk lobes contract after milking. The switch level of automatic cluster removers might then be set higher than 400 g/min for cows milked more frequently.
WHEN AND HOW?

Over-milking might easily be determined by observing some of the following parameters: teat colour and ringing at the base of the teat after detachment, restless or kicking cows during the late flow rate period, nervous first lactation cows, and long milk hoses or claws are empty milking. The response might be to increase threshold values and/or decrease delay time in small steps. It is also necessary to position the claw well so adjusting the load more evenly on the teats, and to use a consistent milking routine in respect to each individual cow. First lactation cows are the future, not the two old cows that are having problems with complete emptying of the udder. It is important to monitor cows with chronic udder infections and to monitor milk yield and strip yield. Strip yields of 100 ml per cow do not cause a decrease in milk yield but the proportion of cows with more than 250 ml of strip yield should not be greater than 10%.

It takes longer to milk out the last kilogram if pre-milking teat preparation is conducted less efficiently or even omitted. Consequently, a good pre-milking teat preparation, a short, consistent interval until attachment, and calm cows are a prerequisite for detachment at a high flow rate. Cows will respond with a shorter machine-on time, excellent teat condition, and proper milking out.

REFERENCES

