

EFFECT OF LINER AGE ON MILKING CHARACTERISTICS

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39th Annual Meeting of the National Mastitis Council, Atlanta, Georgia, 2000

Introduction

The rubber liner is the only part of the milking machine that contacts the cow's teat; therefore, liner performance during milking is of great concern from an economic and herd health standpoint (Hamann *et al* 1994). Rubber liners have been shown to change both their physical and milking characteristics over time in response to absorption of fat and oil (Gardner and Berridge 1952; Gleeson and O'Callaghan 1998). Work is underway to understand the relationship between the changing physical and milking characteristics of the aging liner. The objectives of this study were: (1.) document the average milking characteristics of a particular liner at 840, 1680 and 2520 cow milkings; this was approximately 1, 2 and 3 suggested replacement intervals of the liner and (2.) determine which milking characteristics are most sensitive to liner age.

Materials & Methods

A series of milking time tests were conducted with liners used continuously for nine weeks at the University of Wisconsin-Madison milking parlor. The liners were used to milk 80 cows twice daily by use of a single-4 side-opening parlor. Liners were washed twice daily, followed by an acid rinse/sanitizer, immediately following milking. Paired t-tests involving 16 cows were conducted when the liners reached 840, 1680 and 2520 cow milkings, which was at 3, 6 and 9 weeks of use. Measurements taken during testing were: milking duration, milk yield, average milk flow rate, peak milk flow rate, average mouthpiece chamber vacuum and vacuum fluctuations.

The aging liners in the parlor were the treatment liners, while new liners of the same lot number were the control liners. The control liners were new at the beginning of the study and used throughout. Two clusters of the same make as those in the parlor were equipped with a vacuum transducer on the claw, for measurement of vacuum fluctuations, and a second transducer at the mouthpiece chamber for measurement of mouthpiece vacuum. On the test day, one cluster was fitted with the aged parlor liners and the other cluster was fitted with new liners.

Milking duration and milk yield were obtained from the milk meters installed in the parlor. Average milk flow rate was calculated as milk yield divided by milking duration. Peak milk flow rate was determined as the maximum 30 second average of the milk flow rate from the output of the milk meter. Mouthpiece chamber vacuum during milking was measured with a vacuum transducer inserted into the mouthpiece chamber of the front right teatcup. Vacuum fluctuations were sampled at 100 Hz at the claw with a second vacuum transducer attached to a flexible tube (.25 cm ID x .68 cm OD x 2.9 cm) attached to a metal nipple threaded into the claw. Claw vacuum data was processed in 5-second intervals. For each 5-second interval of milking, the maximum range and derivative (per .01 second) was calculated.

Three classifications of vacuum fluctuations (liner slip) were developed by examining the record of ranges and derivatives for each 5 seconds of milking for 80 cows. As expected, the distributions of the ranges and derivatives were normal. Assuming that liner slip is a rare event, vacuum fluctuation criteria was defined as the 99th, 95th and 90th percentile values of the range and derivative. The threshold values of the three classifications of vacuum fluctuations are shown below in Table 1.

Table 1: Threshold values obtained for three classifications of vacuum fluctuations. Threshold values are the 99th, 95th and 90th percentile values for claw vacuum data on 80 cows

Maximum Derivative (kPa/sec)	Maximum Range (kPa)	Vacuum Fluctuation Classification
102	21	I
64	15	II
56	14	III

Results & Discussion

Table 2 reports the average value obtained with each liner for all measurements. The last two columns report the mean values for all controls and all treatments. An asterisk following a value denotes a statistically significant effect.

Table 2: Mean values for all measurements at each liner age.

	n=16						n=48	
	control	840	control	1680	control	2520	all control	all aged liners
Milking Duration min	8.6	9.3*	6.7	7.5*	8.8	9.4	8.0	8.7***
Milk Yield kg	25.2	24.6	20.2	21.3	19.9	20.7	21.8	22.2
Average Milk Flow kg/min	3.0	2.7	3.2	3.0	2.4	2.3	2.8	2.7*
Peak Milk Flow kg/min	4.7	4.1***	5.2	4.7***	3.9	3.5**	4.6	4.1****
Mouthpiece Chamber Vacuum kPa	11	8.7**	10.1	8.8	9.7	8.6	10.2	8.7***
Vacuum Fluctuation I	1	1	0	1*	0	1	0	1
Vacuum Fluctuation II	1	4****	0	1*	1	2	1	2***
Vacuum Fluctuation III	1	10****	0	3**	2	2	1	5****

Significance: p value < .0500* p value < .0100** p value < .0010*** p value < .0001****

The aged liners in this study produced a decreased peak milk flow rate, increased vacuum fluctuations, increased milking duration, and decreased mouthpiece chamber vacuum. A small but consistent trend in decreased average milk flow rate was also produced by the aged liners. Past studies using aged liners have also found increased vacuum fluctuations (Schwidorski 1965; Kelly, O'Shea, O'Callaghan and McKenna 1983; Gleeson and O'Callaghan 1998; O'Shea and O'Callaghan 1980), and increased milking duration (Gleeson and O'Callaghan 1998).

The correlation between unit stability and higher mouthpiece chamber vacuum was evident in this experiment (Rasmussen, Frimer and Larsen 1996; Mein 1997). The aged liners produced a lower mouthpiece vacuum indicative of air leakage at the mouthpiece lip. Visual inspection of the liners revealed distortion of the mouthpiece, first evident at 840 cow milkings, which may have produced the lower mouthpiece vacuum. However, the liner barrel became elliptical in cross-sectional shape with aging; this elliptical shape was very pronounced by 2520 cow milkings. Since the mouthpiece vacuum of the aged liners continued to be lower than the control liners, barrel distortion- which would increase mouthpiece chamber vacuum- must have been secondary to mouthpiece distortion in this study.

The change in peak milk flow may be the best indicator of liner age since it experienced a significant effect at each test interval. The change in milking duration and vacuum fluctuations II and III may also be good indicators of liner age as they experienced a significant effect when the liners reached 840 and 1680 cow milkings.

Conclusions

☞ This study has shown that the aging liner produces a decreased peak milk flow rate, increased vacuum fluctuations, increased milking duration, and decreased mouthpiece chamber vacuum. A small but consistent trend in decreased average milk flow rate was also produced by the aged liners.

☞ Changes in peak milk flow rate may be the best indicator of liner condition.

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