MEASUREMENT AND CLASSIFICATION OF IRREGULAR VACUUM FLUCTUATIONS (IVF)

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Introduction and Literature Review

Liner condition plays a major role in cluster stability during milking. The term liner slip has been used to describe events such as the liner falling off the teat, an audible liner “squawk”, and inaudible air admission to the liner. Air is admitted to the liner when the seal between the teat and liner mouthpiece is broken. The air admission resulting from these events cause vacuum change in the liner, short milk tube and claw. We propose use of the term Irregular Vacuum Fluctuations (IVF), coined by the late J.F. Nyhan and M.J. Cowhig, to describe the vacuum changes produced by this infrequent and unplanned air admission (Thiel 1978).

Liner slips have been measured by airflow into the teatcup using a hot wire anemometer located at the outlet of a weigh jar (O’Shea et al. 1980). Other work has defined a liner slip simply as an audible squawk (Gibb and Mein 1976; Galton et al. 1990; Rasmussen et al. 1998), or a complete unit fall-off (Gibb and Mein 1976). Studies by Spencer and Voltz (1990) and Baxter et al. (1992) identified liner slips by monitoring the change in claw vacuum. Spencer and Voltz (1990) characterized liner slips by a change in vacuum of 8 kPa or more occurring in 0.2 seconds or less. Baxter et al. defined a liner slip as a deviation of 10 kPa from the average claw vacuum in 0.25 seconds. The results of both of these studies may have been affected by the methods and instruments used to measure claw vacuum.

Objective

The objective of this study was to develop a practical set of criteria for classification of IVF based upon measurements of the amplitude and derivative of claw vacuum using methods and instruments capable of measuring the true vacuum changes.

Materials and Methods

The vacuum measurement system used to measure claw vacuum had a sample rate of 100 Hz and response rate of 20,000 kPa/s (Reinemann et al. 1997). The milking cluster used for testing consisted of a Bou-Matic Flow Star© claw with Visi-Shell© teat cups. Vacuum level was maintained between 37 and 41 kPa (10.9-12.1 in Hg) at the claw, pulsation rate was 57 per/min, ratio of 60:40 front and rear during the year of testing. A total of 80 cow milkings were conducted half of the observations with new liners and the other half with aged liners as described in Davis et al. 2000. The maximum range (maximum – minimum), and derivative (change in vacuum per 0.01s) of claw vacuum were calculated for each 5-second interval of milking.

Results

The maximum range and derivative of claw vacuum were normally distributed about a mean value but with extended tails on the positive side of the mean. The vacuum fluctuations produced during 'normal milking" include small, rapid changes in vacuum and large changes at a slow rate. Air admission to the liner produces liner slips with both large amplitude and rapid change in vacuum. The combination of some critical amplitude and rate of change is required to produce reverse pressure gradients in the short milk tube. The 99th, 95th and 90th percentile values of the range and derivative are presented in Table 1.

Table 1. Threshold values obtained for three classifications of vacuum fluctuations.

Percentile of distribution	Maximum derivative (kPa/s)	Maximum range (kPa)
99	21	102
95	15	64
90	14	56

The similarity of the values at the 95th and 90th percentiles suggests two criteria for classifications of IVF. We suggest the following two levels of combined criteria for vacuum range and rate of change in the claw to classify IVF during milking:

IVF 1 = derivative $\geq$ 100 kPa/s and range $\geq$ 21 kPa
IVF 2 = derivative $\geq$ 56 kPa/s and range $\geq$ 14 kPa

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