Evaluation of the opportunities for continuous monitoring of milking installations

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Summary

An overview of possibilities of continuous monitoring of milking installations is made, based on a literature review and a market survey of possible sensors. The importance of some measuring points (vacuum, air consumption, vacuum pump, pulsation, attachment of clusters, liner slips, milk transport, abnormal milk, cleaning, operator faults, cow behaviour, milk cooling and electric supply stray voltage) and possibilities of monitoring are evaluated.

***Key words**: Milking machine, monitoring system, sensors*

Introduction

Today, commercial monitoring systems can already detect malfunctions in an early stage and prevent serious problems (e.g. bad teat conditions, mastitis, etc.). The availability of reasonably priced and reliable sensors and processing devices might make continuous monitoring (CM) of milking installations in the future cost-effective.

Possibilities of CM

For an optimal milking process, the installation should maintain the desired vacuum at the teats. Checking this requires many sensors, difficult to build in and inappropriate for CM. A solution is to check the vacuum in the receiver, the milkline and the airline at the vacuum pump inlet and at the regulator. The measurements have to comply with ISO 5707. Literature mentions several vacuum sensors for on-line measurement. In wet locations, milk residues can block the connections of sensors with a small internal measuring chamber. This affects not only the measurements (Rasmussen et al. 2003), but is not hygienic either. A flush mounted sensor can be hygienic, but the diaphragm can be sensitive and break quickly. There are besides research systems (e.g. Bray et al.,1998; Spencer, 2000), some commercial systems which include functional checks for vacuum (e.g. vacuum gauge from A/S S.A. Christensen & co, "DairyDaq" from Viper Technology, "DairyTest Monitor" from InnovAg).

A pulsation stop affects the milking and causes harm to teats. A CM system should check if the pulsators are operating. The DeLaval EP70 Pulsators have such a control. Pulsator characteristics can change with time and faults in pipes and tubes can change the pulsation chamber vacuum record. A CM system can detect such faults before udder health is affected. Some research systems (e.g. Bray et al., 1998; Spencer, 2000) and commercial systems (e.g. "Pulse-O-Rater" from Bou-Matic, "DairyDaq" from Viper Technology) which monitor pulsators already exist.

During a liner slip, air enters the clusters, resulting in an unstable vacuum. Spencer (1990) describes an in-line liner slip counter. This system is however not yet suitable for CM. On-line measuring vacuum in the mouthpiece chamber is namely technically difficult.

The most frequent reason for defect with oil-sealed pumps is lack of lubrication. An alarm for low oil level could prevent this. A water ring vacuum pump requires a certain amount of seal liquid to operate at the design pressure. Insufficient liquid may result in reduced capacity or cavitations in the pump. A flow switch can alert if seal liquid flow is low. A temperature sensor in the pump body can indicate problems, including increased exhaust pressure. For water ring pumps, the temperature of the seal fluid affects the vacuum at which the pump operates. Several vacuum pumps nowadays have a temperature security device, which can make the pump turn slower or can switch it off.

The amount of air admitted by the regulator during normal milking indicates the ability of the system to cope with irregularities of air admission. Another monitoring point is to discover and to locate air leakages, allowing a quick repair of malfunctions. Existing flow sensors cannot fulfil the ISO 5707 requirements, due to creating a too high a vacuum drop. Moreover, pulsations and fluctuations from irregularities cause inaccurate measurements. A solution is to detect air leaks by interpreting the vacuum variations.

Milk meters, individual cow identification and timing allow monitoring of the milking dynamics, as well as parlour performance (Maltz et al., 2004, Eicker et al. 2000). This is possible as milk flow curves per cow are to a high degree repeatable. They change however with an increasing lactation period and the same errors in handling and in milking equipment among the individual cows may have different effects (Steidle et al., 2000). The data captured by milk meters, vary moreover widely between different manufacturers (Eicker and Stewart, 1998). Some milk meters only measure the total amount of milk per cow. A milk meter as the Lactocorder (Steidle et al., 2000) can register further useful parameters. A rare bimodality in milk flow curves is an expression of milking readiness whereas frequent occurrence signals stimulation deficits. A short plateau with reduced flow signals defects in vacuum and/or milk delivery. A long decline is due to milking out and then overmilking individual quarters. The milking gear position influences the ratio between plateau and decline. The Lactocorder also determines the time of overmilking by the machine and it registers abrupt air leakages.

At present, there are no standards defining abnormal milk or describing how to detect abnormal milk. At Lelystad (2004), Rasmussen presented proposals for such standards. There is much research on this topic. Several on-line sensors are being developed, but as far as known, none of them is commercially available yet in a suitable version.

The cleaning procedure comprises many elements, which can fail and cause contamination of the milk (interruption in heating, water or detergent supply). CM of the cleaning process can be more or less comprehensive as such monitoring systems already exist.

Milk cooling is essential to prevent contamination of the milk. A monitoring system could be more or less comprehensive, as monitoring systems for a milk bulk tank exist. In some countries (e.g. Belgium) such a system is even obligatory.

Leakage currents can disturb the milking process. Cows are more susceptible to stray voltages compared to humans due to the cows' relatively lower body resistance (Lefcourt, 1991). The sources of relatively small electrical currents passing through animals are often difficult to locate and it is often unclear how to calculate the current through the animal. Therefore, monitoring of the electric supply stray voltage is a task of specialists.

Conclusion

A CM system could today contain monitoring of vacuum levels at several points in the milking installation, of pulsators, of the proper working of vacuum pumps, a basic monitoring of the milk transport, the milker and the cow with milk meters and monitoring of the cleaning of the installation as well as the cooling of milk. Research promises to add further monitoring possibilities with vacuum meters, with milk meters and monitoring of abnormal milk in the future. Monitoring of air consumption or electric supply stray voltage is not ready for CM.

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References

Bray, D. R., Fowler, P. A., Fialho, F. B., Bucklin, R. A., Yeralan, S., Tran, T. & Braun, R. K., 1998: An automated system for monitoring milking system parameters. In Proceedings of the 37th National Mastitis Council Annual Meeting, St. Louis, Missouri, 127-136.

Eicker, S. W., Stewart, S. C. , 1998: Computerized parlor data collection and use: „Monitoring the cows, the people, and the parlor“. In Proceedings of the 37th National Mastitis Council Annual Meeting, St. Louis, Missouri, 98-107.

Eicker, S., Stewart, S., Reid, D. & Rapnicki, P., 2000: New tools for measuring the effect of stimulation and take-off on milk flow. In Proceedings of the 39th National Mastitis Council Annual Meeting, February 13-16, Reno, Nevada, 127-133.

ISO 5707, 1996: Milking machine installations – Construction and performance. Geneva, Switzerland: International Standards Organization.

ISO 6690, 1996: Milking machine installations – Mechanical tests. Geneva, Switzerland: International Standards Organization.

Lefcourt, A.M., (Ed), 1991: Effects of Electrical Voltage/Current on Farm Animals: How to Detect and Remedy Problems. U.S. Department of Agriculture, Agriculture Handbook No.696, pp 142.

Maltz, E., Livshin, N., Aizinbud, E. & Tinsky, M., 2004: Real-time sensors in the milking parlor as a tool to monitor cows' milk let down and parlor performance to improve milking routines and operation efficiency. In Proceedings of AgEng Engineering the Future, September 2004, Leuven, Belgium, 580-581.

Rasmussen, M. D., Reinemann, D. J. & Mein, G. A., 2003: Measuring Vacuum in Milking Machines. Bulletin-FIL-IDF (Belgium). International Dairy Federation. 381, 19-32.

Rasmussen, M. D., 2004: Detection and Separation of Abnormal Milk in Automatic Milking Systems. In Proceedings of Automatic Milking a better understanding, March 2004, Lelystad, The Netherlands, 189-197.

Spencer, S.B. & Volz, C., 1990: Measuring milking machine liner slips. Journal of Dairy Science 73, 1000-1004.

Spencer, S. B., 2000: New developments for the use of data acquisition for milking system analysis. ASAE Annual International Meeting, July 2000, Milwaukee, Wisconsin. Paper N° 003013.

Steidle, E., Goeft, H., Immler, S., Rosenberger, E., Korndoerfer, R., Duda, J., Troeger, F., Bruckmaier, R., Worstorff, H., Model, I., Harch, M. & Deneke, J., 2000: Lactation Consulting with Milk Flow Curves. Bayerische Landesanstalt fuer Tierzucht Grub, pp 118.