Otto Kaufmann and Jens Unrath, Berlin

# Environmental Factors in Automatic Milking Systems

*Components of the automatic milking system (AMS) production environment are temperature, humidity, air composition, as well as noise load. These factors were tested beside a milking robot. The results show that optimal conditions in the micro-climate and air quality, as well as the noise level within the AMS, are not present. Based on this, the recommendation is to re-create the structure of the milking box*

Prof. Dr Otto Kaufmann is head of the Department of Animal Husbandry and Engineering at the Institute of Animal Sciences at the Faculty of Agriculture and Horticulture of Humboldt-University at Berlin, Philippstr. 13, 10115 Berlin; e-mail: *otto.kaufmann@agrar.hu-berlin.de*

Dipl.-Ing. agr. Jens Unrath is member of the scientific staff at the Institute of Rural and Urban Ecological Projects at Humboldt-University at Berlin, Invalidenstrasse 42, 10115 Berlin. He is also PhD-student at the Department of Animal Husbandry and Engineering in the Institute of Animal Sciences at the Faculty of Agriculture and Horticulture of Humboldt-University at Berlin; e-mail: *jens.unrath@agrar.hu-berlin.de*

## Keywords

Production environment, AMS, house climate, sound level

## Literature

Literature references can be called up under LT 04221 via internet http://www.landwirtschaftsverlag.com/landtech/local/literatur.htm.

Automatic Milking Systems (AMS) have been analysed in a number of tests. These tests were related to functional safety, animal behaviour, animal health, milk quality, milking hygiene, economy and productivity. Environmental factors, which have an effect on the animal in automatic milking systems, have so far found very little attention. This concerns the production environment during the milking process and includes the climate in the milking box with the factors: temperature, humidity and air composition. Besides these factors the sound level and the degree of dirtying, combined with bacterial colonisation at the AMS' surface can be put into consideration.

Widely unknown are the effects of environmental conditions within the AMS on the animal. There are indications of an influence of the conditions within the AMS on the frequency of milking box visits by the animals as well as on the risk of infections [1, 2].

In order to be able to make related statements, first of all it is necessary to characterise the conditions inside the AMS. This was the goal of an analysis, which was concentrated on the following crucial points:

- climate conditions, including air composition in AMS
- sound level in AMS
- dirtying and bacterial colonisation at the AMS' surface

In the following the results regarding climate and sound investigations are presented.

### Material and Method

Investigations have been carried out in a dairy farm with 120 cows. The cows have been milked by two centrally in the stable located AMS Lely Astronaut® systems. *Table 1* shows measuring techniques and measure points for data processing. Climate data were measured during three experimental steps. In order to put seasonal influences into consideration, the experiments have been carried out on seven consecutive days in March and June, 2002, and in January, 2003. Sound level measurements were taken on two days. The steady repetitions of measurements lead to a stereotype run of the sound level, depending on the procedural steps of the milking process.

### Results

*Climate parameter and air composition within the analysis period in June, 2002*

The summer situation was characterised by measured temperatures between 16.5 and 35.1 °C. By using the Box-and-Whiskers-Plot the data distribution shows that 50 % of the data can be found at a level between 19.7 and 23.9 °C. In 10 % of cases temperatures have been mesuared between 26.5 and 29°C. It was obvious that the temperatures within the AMS were related to the stable temperatures. The relative humidity shows data between 34 and 86 %. Half of these data were

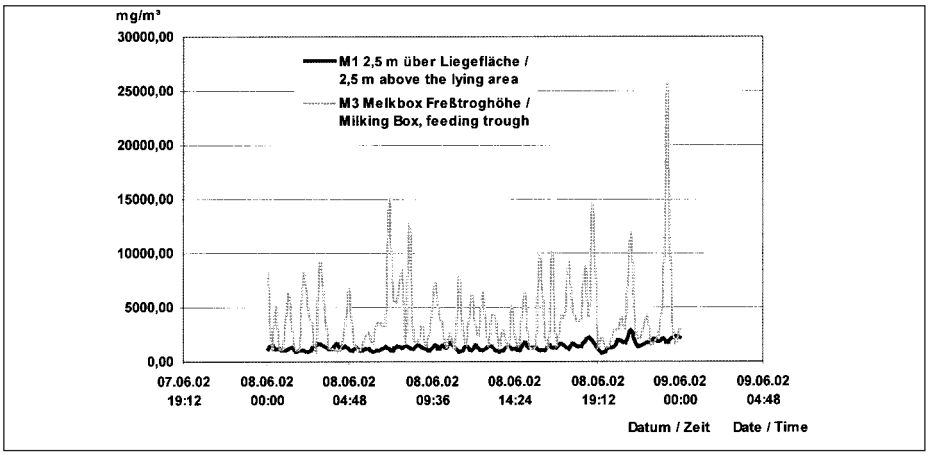


*Fig. 1: Concentration of carbon dioxide in the air at measuring points in the stable (M1) and AMS (M3)*

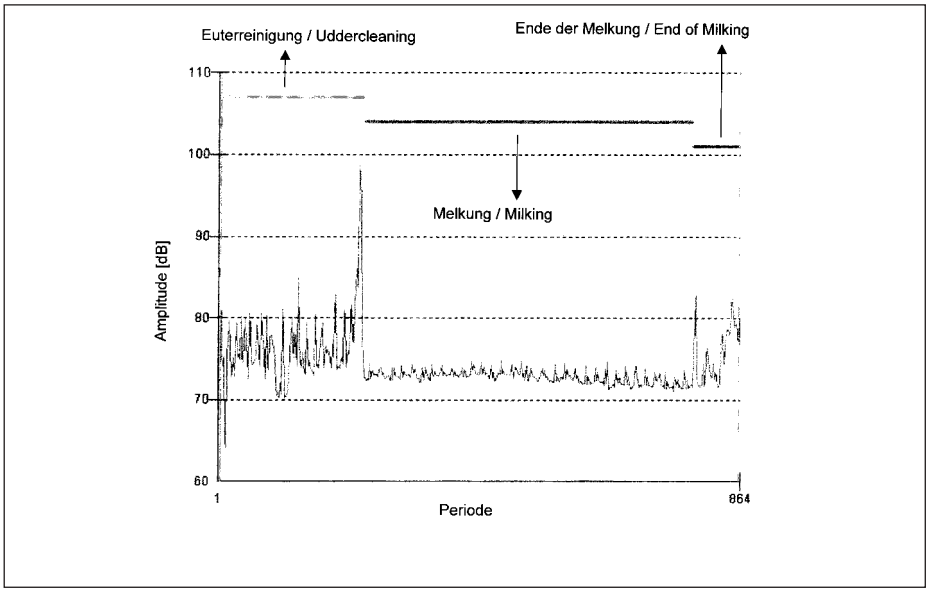


*Fig. 2: Sound level during the milking process in the AMS in dB(A), 1 period = 0.5 s*

distributed between a humidity of 57 and 75 %, while 10 % was found between 80 and 84 % humidity. Within the inter-quartile section, a humidity between 6 and 12 % higher than in the stable was found.

For the concentration of ammonia in the air within the AMS data between 0.37 and 4.05 mg/m$^3$ have been measured. In the inter-quartile section those data were between 0.76 and 1.72 mg/m$^3$.

Development and distribution of carbon dioxide and methane concentration within the AMS was of special interest. These two gases are produced by cows during their stay in the milking box. The concentration of these gases expresses explicitly the ventilation conditions within the system. Data processing by a sensor, located directly besides the fodder box inside the AMS, showed the following results: a methane concentration within the inter-quartile section between 13.2 and 80.9 mg/m$^3$ was found. Carbon dioxide concentration reached levels between 1,329 and 4,289 mg/m$^3$. 10 % of all analysed air composition data for methane were between 226.3 and 563.3 mg/m$^3$ and for carbon dioxide between 7,219 and 14,128 mg/m$^3$. *Figure 1* shows the concentration of carbon dioxide by comparison between air in the stable and air in the milking box during the run of a day. Immense differences can be seen.

*Sound level within AMS*

From a scientific as well as a practical point of view the estimation of the importance of sound in animal husbandry still remains difficult. The reason for this is the fact that the effect of sound on animals is still widely unknown. Especially unclear is at what level animals regard echo in combination with frequency as noise. That is why human guidelines are introduced in order to judge echo and noise in animal husbandry. *Figure 2* shows the run of the sound level in dB(A) within the AMS during one milking procedure. The run is divided into udder cleaning, milking and end of the milking. It becomes obvious that there is a high noise level developing during the cleaning of the udder. This cleaning process is finished with a cleansing and disinfection of the cleaning brushes by high-pressured air and water. During this process the sound level amplitude rises for 3.5 seconds to almost 100 dB(A). During the main milking process the sound level lies between 70 and 75 dB(A). At the end of the milking there is again an increase in sound level. Besides the change of sound level a change of frequency has been found. The degree of noise load is characterised by the level of sound, frequency and duration of action on the animal. Investigations show that cows are under the influence of noise for up to 2 minutes during each milking process. The sound level reaches 80 up to 89 dB(A) at a frequency between 0.5 and 8 kHz.

| **Parameter** | **Measuring technique** | **Measuring points** |
|---|---|---|
| Temperature & rel. humidity | Temperatur und Luftfeuchtigkeitslogger, TESTO, Deutschland<br>Messgenauigkeit für<br>Temperatur: ± 0,5°C<br>rel. Luftfeuchte: ± 5% | • Milking box, height of the animal head<br>• stablel<br>• outdoor |
| Gas | Multigasmonitor, Type 1302, Fa. Bruel & Kjear, Dänemark<br>Einsatz mit Hilfe des Mehrprobenehmers 1309<br>Eingesetzte Filter/ Nachweisgrenze<br>$NH_3$ UA 0976 / 0,2 ppm<br>$CO_2$ UA 0982 / 1,5 ppm<br>$CH_4$ UA 0987 / 0,10 ppm | • Milking box, height of the animal head<br>• stable<br>• outdoor |
| Sound | Environmental Sound Analyser, Nor- 121, Norsonic, Norwegen<br>Mikrofon<br>Kondensatorenmikrofon<br>Norsonic Typ 1225<br>Mikrofonkabeleinfluss < 0,1 dB<br>Bezugsschalldruckpegel 114 dB | • Milking box<br>• different parts of the stable |

*Table 1: Measuring techniques and measuring points*

## Discussion

The success of automatic milking is also dependent on the willingness of the cows to voluntarily enter the milking box without human help. In order to do so they are motivated by feeding concentrates to them during each milking process. This motivation can be influenced in a negative way, if certain conditions within the AMS appear unattractive to the animal. This includes production environment factors such as climate, air composition and noise load. Research was carried out under summer conditions. It became clear that those temperatures measured in the AMS and the relative humidity are above those levels which the animals prefer [3].

High concentrations of carbon dioxide in the AMS are caused by the cows' breathing, and indicate poor ventilation. It is well known that cows prefer well-ventilated feeding spaces. That is why the concept of construction as well as ventilation of milking boxes within automatic installations should be improved. Improved ventilation conditions can lead to slower heat accumulation.

For the evaluation of the measured sound, data from analyses of milking parlours had to be used. The authors [4, 5] conclude, that sound levels between 65 and 70 dB(A) should not be exceeded. Our measurements show for the inter-quartile, results between 72 and 75 dB(A). The noise influence during the cleaning by brushes seems to be a problem. Here new technology should be developed, which is less noisy in order to remove another possible source of negative influence on the cows.