Monitoring System of Pulsation Processes in a Milking Machine

Anatolii. T. Aleksandrov[1] and Nikola D. Draganov[2]

***Abstract* – The paper treats alternative solutions for monitoring and control of the processes taking place in the milking bowl of a milking machine.**

Observations have been conducted and experimental recordings have been made of the processes in the milking bowl of the milking equipment using a video camera placed in the milk chamber of the milking machine. Experimental results have also been obtained using an optic and a galvanomagnetic sensor.

On the basis of the results obtained a comparative analysis has been made and conclusions have been drawn about the operation of the milking machine.

***Keywords* - milking bowl, milk chamber, video camera, optic sensor, galvanomagnetic sensor**

I. INTRODUCTION

Modern stockbreeding requires constant development and improvement of its automation tools. Milking machines are widely applied as tools for labour automation in stockbreeding, and they determine to a great extent the efficiency, as well as the cost and quality of the milk [2, 3, 4, 5]. It is interesting to study the processes taking part in the teat cup cluster of the milking machines and to establish the relationship between the operation of the pulsator and the position of the rubber teat cup.

The aim of the present paper is monitoring, study and control of the processes in the teat cup cluster of the milking machine. Its implementation creates conditions for improving the operating characteristics of the milking machines. [2-6]

II. INSTRUCTIONS FOR THE AUTHORS

To improve the operation and efficiency of milking machines, a good knowledge and description of the processes taking place in the teat cup cluster is necessary. To achieve this, alternative solutions for monitoring and control of these processes have to be developed.

Experiments have been conducted for observing the processes taking place in the milking chamber, using a video camera, model GV250, enabling transmission and processing of information on a PC [7] .

[1] Anatolii T. Aleksandrov is with the Technical University, 4 H. Dimitar str. 5300 Gabrovo, Bulgaria, E-mail: alex@tugab.bg

[2] Nikola D. Draganov is with the Technical University, 4 H. Dimitar str. 5300 Gabrovo, Bulgaria, E-mail: nikola_draganov@mail.bg

The circuit of the test setting is shown in Fig. 1. The lens of the video camera (CCD matrix) 3 has been mounted in the artificial teat 2. LEDs 4 have been mounted around the video camera, which provide background light of the video camera. The control block 1 of the camera provides the connection to the personal computer 7 by means of a video cable 6. The video block created in this way is placed in the teat cup 8 of the teat cup cluster 9. Block 5 is composed of a LED and its function is to light the inside of the teat cup. The power supply of the test setting is provided by two stabilized rectifiers 10 and 11.

The video camera, model GV250, enables transmission and processing of information on a PC using the GeoCenter software. It has a resolution of 420 lines per frame. The video controller GV-600V2, operating on an NTSC video system, can have 4 video cameras connected to it. There is no storbing input, but frame synchronization is possible by means of the

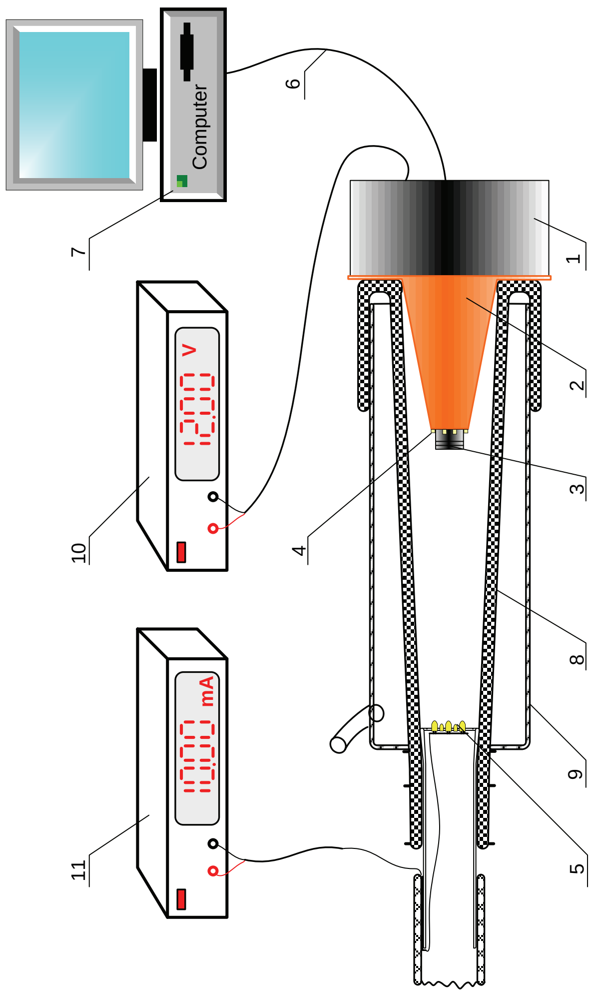


Fig. 1. Circuit of the test setting

camera illuminance.

The minimum configuration that the PC needs to have for the video controller and the camera to be installed is:

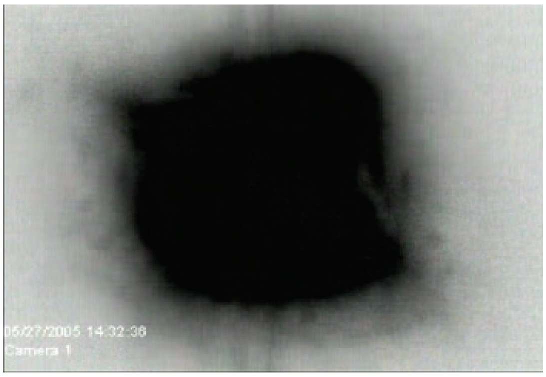


Fig. 2. Frame of the milking chamber from the first phase of the milking process – “squeeze” phase

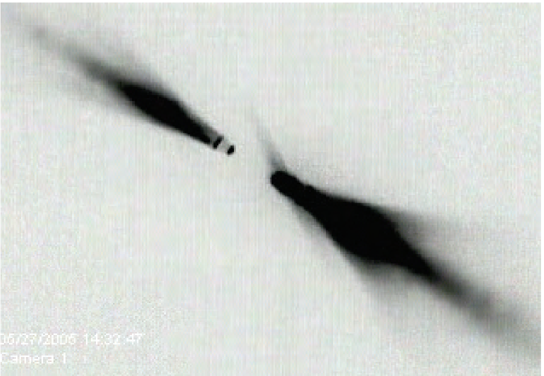


Fig. 3 Frame of the milking chamber from the second phase of the milking process “massage + stimulation”

Windows-98 operating system, CPU-Pentium II, 128MB RAM, 144MHz Bus speed, 16MB video controller, 15GB HDD. [7]

A film of any duration and extension *.avi can be recorded.

The test setting enables recording and monitoring of the processes in the teat cup cluster at different illuminance, with or without background light. The film can be broken into frames, the resolution being 25 frames per second using WirtualDibMod software product. Therefore, in addition to monitoring of the processes taking place in the teat cup cluster, photographs can be taken at specific moments, as well as qualitative and quantitative assessment of the shape of the milking chamber.

Fig. 2 and Fig. 3 show frames of the milking chamber from the first phase of the milking process – “squeeze” phase, and the second one – “massage + stimulation”.

The experiments that have been conducted give a good qualitative picture of the processes taking place in the teat cup cluster. By processing the resultant image using the MathCAD 2000 software package (Fig.4 and Fig.5), a quantitative assessment of the processes in the milking chamber can be obtained. The results are subject to further processing and analysis.

The processes in the milking chamber of the teat cup cluster have been studied experimentally using optical and galvanomagnetic sensors as well [1, 6]. Fig.6 presents the flow chart, and Fig.7a and 7b– the conceptual electric circuits

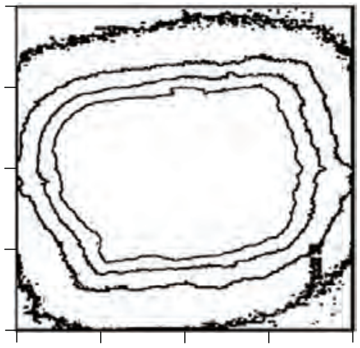


Fig. 4. Processing the resultant image using the MathCAD 2000

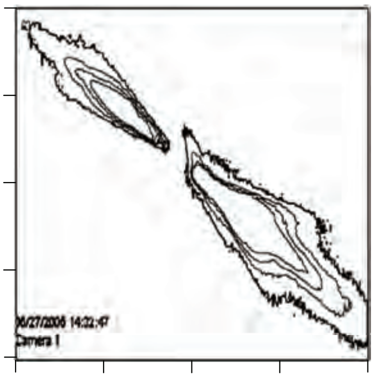


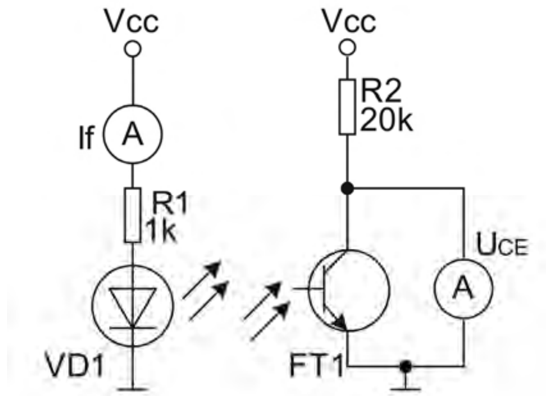
Fig. 5. Processing the resultant image using the MathCAD 2000

of the test settings. Both types of sensors provide information about the state of the rubber teat cup by means of double energy conversion.

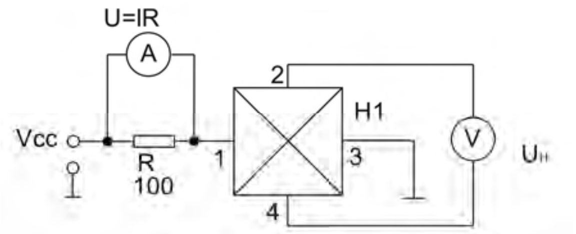
In the circuit with the optical sensor the photosensitive element (phototransistor 3) has been mounted in the artificial teat 5 in place of the video camera. The milking chamber 8 is lit by means of LEDs 4. Under the action of the vacuum the teat cup 7 contracts and the luminous flux to the phototransistor is reduced, i.e. the position of the teat cup is converted into an equivalent light signal. The light signal is converted into an equivalent electrical signal in the phototransistor. [1, 6]

The galvanomagnetic sensor also gives indirect information about the contraction of the teat cup. This is achieved by sticking a magneto-sensitive element – Hall element 1 on the outer surface of the teat cup. A permanent magnet 2 is fixed against it. When the teat cup is loose, the distance between the magneto-sensitive element and the magnet is equal to the diameter of the teat cup in this area. In this case the Hall voltage measured by the voltmeter 12 will be the lowest. When the teat cup contracts as a result of the vacuum, the distance between the magnet and the Hall element is shortened. The generated Hall voltage will rise as the contraction of the teat cup increases [1].

The conversion characteristics measured experimentally $U_{CE}=f(L)$ (U_{CE} – voltage drop across the phototransistor; L – internal diameter of the teat cup) at I_F=const (I_F – current across the LCD) with the optical sensor are shown in Fig.8, and the conversion characteristics $U_H=f(L)$ show the change



a)



b)

Fig. 7. Conceptual electric circuits of the test settings

in the diameter of the teat cup as a function of the Hall voltage (U_H – Hall voltage; L - internal diameter of the teat cup).

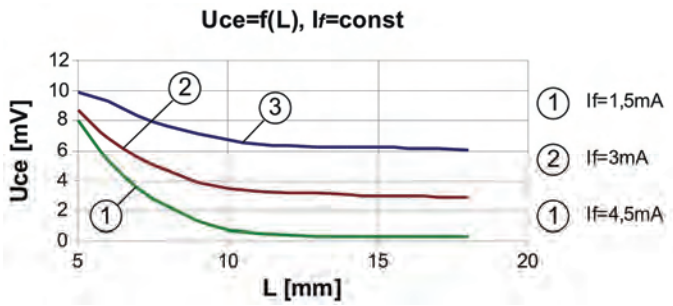


Fig.8. Conversion characteristics measured experimentally with optical sensor

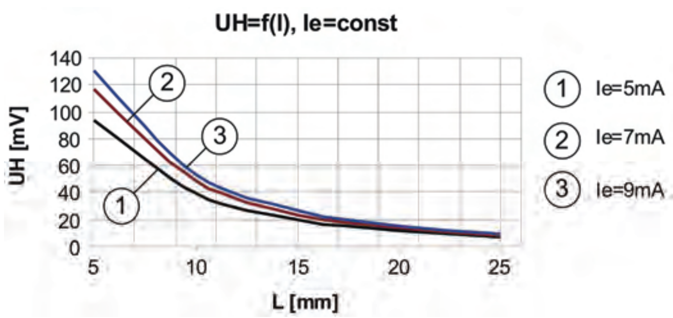


Fig. 9. Conversion characteristics measured experimentally with galvanomagnetic sensor

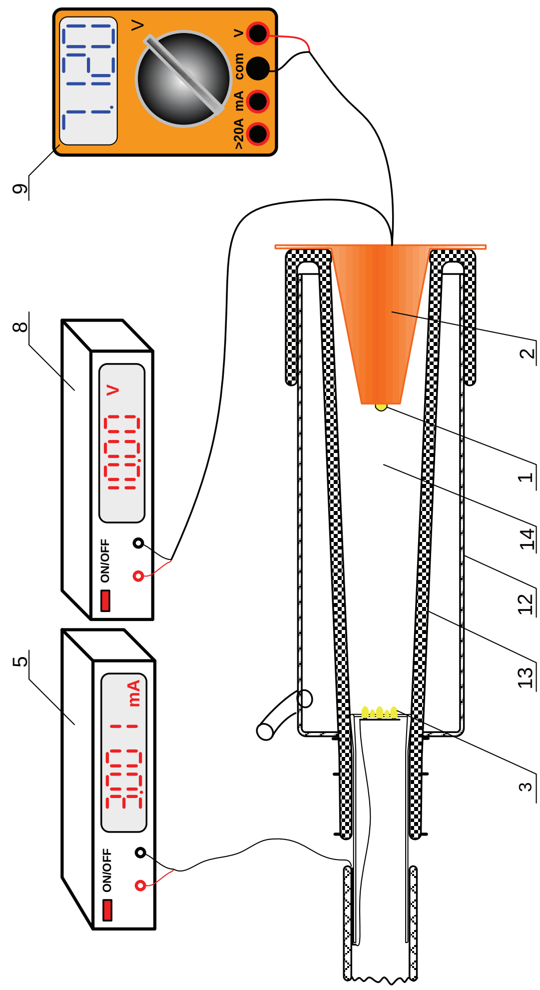


Fig. 6. Circuit of the test setting for optical and galvanomagnetic measurements

Both signals are information signals and can be used successfully for monitoring and control of the processes in the milking chamber.

The conversion characteristics measured experimentally enable indirect quantitative assessment of the degree of contraction of the teat cup through the value of the voltages measured (U_{CE} and U_H), depending on the sensor used.

Although the conversion characteristics are not linear, they can be used for control of the milking machine, since the two final states of the teat cup are important – squeezed and loose.

The conversion characteristics that exhibit the greatest conversion transconductance are the ones obtained for current across the LED I_F=1,5mA and current across the Hall element Ie=9mA, which also determines higher sensitivity of the respective sensors in these operation modes [1,6].

III. CONCLUSION

Experimental studies have been conducted of the processes taking place in the teat cup cluster of the milking machine, using a video camera, model GV250, enabling transmission and processing of information on a PC by means of GeoCenter software.

Circuits with an optical and a galvanomagnetic sensor have been proposed for studying the processes in the milking chamber. Experimental conversion characteristics have been obtained, and the voltage values U_{CE} and U_H that have been measured are used as a quantitative criterion for assessing the degree of contraction of the teat cup.

The video camera and the test setting for studies by means of an optical sensor can only be used in the simulation of the milking process, while the test setting with the galvanomagnetic sensor can find application under actual working conditions.

REFERENCES

[1] Alexandrov, A. Discrete Semiconductor Elements, Gabrovo, Vasil Aprilov Publishing House, 2002 (in Bulgarian).

[2] Banev B., V. Valashev, K. Peichev, Al.. Blagoev. Study of pulsation camera of milking machine working with vibration-pulsator "Biopuls", periodical "Stock-science", 1987, 311-316.

[3] Banev B., K. Peichev. Study of stress from of the rubber teat cup over false teat, SU Stara Zagora, 2003, p II, 286-288.

[4] Banev B., B. Bonchev. Study of possibilities to use of pulse machine "POLANES" in milking machine for sheeps, periodical "Agricultural technics", 2004, №5, 33-37.

[5] Valashev V., K. Peichev, B. Banev. Analysis of mechanical performance of rubber teat cup with different level of tighten, periodical "Agricultural technics" 2003, №3, 58-60.

[6] Valkov S. A. Electronics and semiconductors elements and integrated circuit, Sofia, Technics, 1992

[7] www.geocenter.com, from September 27.2005